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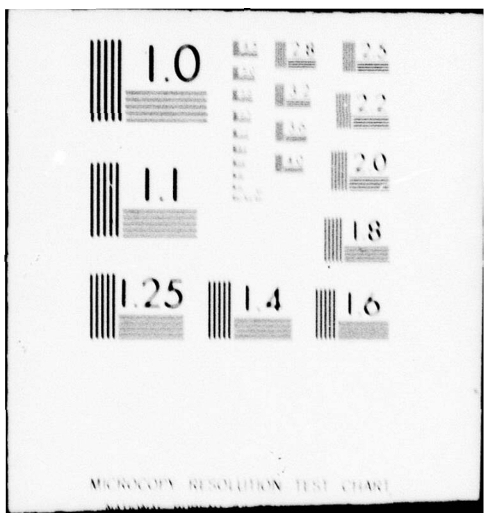
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AFFDL-TR-78-2
VOLUME II

LEVEL II

NEW CONCEPTS IN COMPOSITE MATERIAL LANDING GEAR FOR MILITARY AIRCRAFT
APPENDICES
VOLUME II

ROCKWELL INTERNATIONAL, LOS ANGELES DIVISION
LOS ANGELES, CALIFORNIA

FEBRUARY 1978

TECHNICAL REPORT AFFDL-TR-78-2, VOLUME II

FINAL REPORT FOR PERIOD APRIL 1976 - FEBRUARY 1978

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

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This technical report has been reviewed and is approved for publication.

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report covers the work performed through Phase I under Air Force Contract F33615-76-C-3021, "New Concepts in Composite Material Landing Gear for Military Aircraft." The effort during Phase I included the selection of the landing gear system to be studied, the documentation of the baseline requirements and constraints data, the conceptual design and evaluation of three distinct concepts having different constraints, plans for 1/5 scale models, and methodology to be used during the Phase II section of the program.

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Phase II of this program will include preliminary designs for complete landing gear system for all three concepts, the construction of the 1/5 scale working models of the Concept 2 and Concept 3 designs, cost and weight comparisons of each concept and preparation of data plots to illustrate the weight, cost, and life-cycle cost advantages of composite material hardware for landing gear.

The B-1 Nose Landing Gear has been used as the baseline and the hardware has been modified to use composite material for structural parts under the three different degrees of constraint. Concept 1 was constrained by "form, fit and function"; Concept 2, by "fit and function"; and Concept 3 by only the "function" constraint.

Concept I, substitution (form, fit and function) parts have been designed and some have composite material spliced to metal end fittings to meet the high load requirements within the form constraint. These designs were not weight effective.

Concept II, modified (fit and function) parts, using existing structural attachments, but revised kinematics, have been designed to foster increased usage of composites. The piston and lower end of the strut cylinder have been kept metallic since the larger diameter required for composite parts would result in spreading the wheels which would violate the stowage limit contraints. Increased usage of composites and improved weight effectivity was gained by reducing the constraints.

Concept III, redesigned (function) parts utilize a system which requires a slightly larger wheel well bay to accommodate the revised nose gear. This allowed the wheels to be positioned farther apart to allow room for a composite axle, piston and strut. This further reduction in constraints allowed more parts to be made from composites and further increased weight effectivity.

The methodology section of this report shows the approaches, methods and comparisons which will be used during Phase II to determine the pay-offs possible through the maximum usage of composite material in a landing gear system.

FOREWORD

This is Volume II, Appendices, of a two volume Final Report which was prepared by the Los Angeles Division of Rockwell International, Los Angeles, California, under United STates Air Force Contract F33615-76-C-3021, Air Force Project No. 2402, Task No. 240201, "New Concepts in Composite Material Landing Gear for Military Aircraft." The program is being administrated by the Air Force Flight Dynamics Laboratory, Wright-Patterson Air Force Base, Ohio, under the direction of Mr. J. Hampton (AFFDL/FEM).

This volume contains the Appendices to Volume I, the final report, covering work performed from April 1976 through February 1978. Volume I of the report contains the technical discussion. Rockwell International personnel directly participating on the program were:

V. E. Wilson	Program Manager
F. W. Atkins	Systems Engineer
J. Rohlen	Structures Engineer
J. Kirkhoff	Contract Administration

The report was submitted in February 1978.

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PHASE I REPORT

NEW CONCEPTS IN COMPOSITE

MATERIAL LANDING GEAR

FOR MILITARY AIRCRAFT

SECTION I

INTRODUCTION

Composite materials have outstanding strength and stiffness characteristics which can be used advantageously in the design of landing gear hardware The objective of this program was to explore the extent to which composite material could be used in a complete landing gear system, and the cost and weight benefits that could result from this usage.

The Air Force, through AFFDL, has sponsored a number of successful composite landing gear hardware programs. These have established the feasibility of using composite material for certain landing gear components, but all hardware designed was constrained by "form, fit and function." This program has three separate sections so that hardware was designed under three distinct levels of constraint. The first is "Substitution," with "form,fit and function" constraints. The second section is "Modification" with both "fit and function" constraints. The third section is "Redesign" with only the "function" constraint.

This program is phase oriented with this report covering Phase I. Phase II will not be started until this report and a presentation of its contents is approved by the Air Force. A Phase I and Phase II task flow diagram is shown in figure 1.

The approach used for the Phase I section followed the task outline shown in figure 1 and resulted in the choice of the B-1 Nose Landing Gear, see figure 2, as the baseline. Conceptual designs for composite landing gear hardware were then developed for each section and level of constraint as described above. Methodology to be used in the Phase II preliminary design and to be used in generating data plots to illustrate the advantages of composite landing gear hardware has been determined and documented in the Methodology Section.

Evaluations of the design concepts created in this phase were then used as the basis for recommendations of concepts which should be carried into Phase II for preliminary design effort.

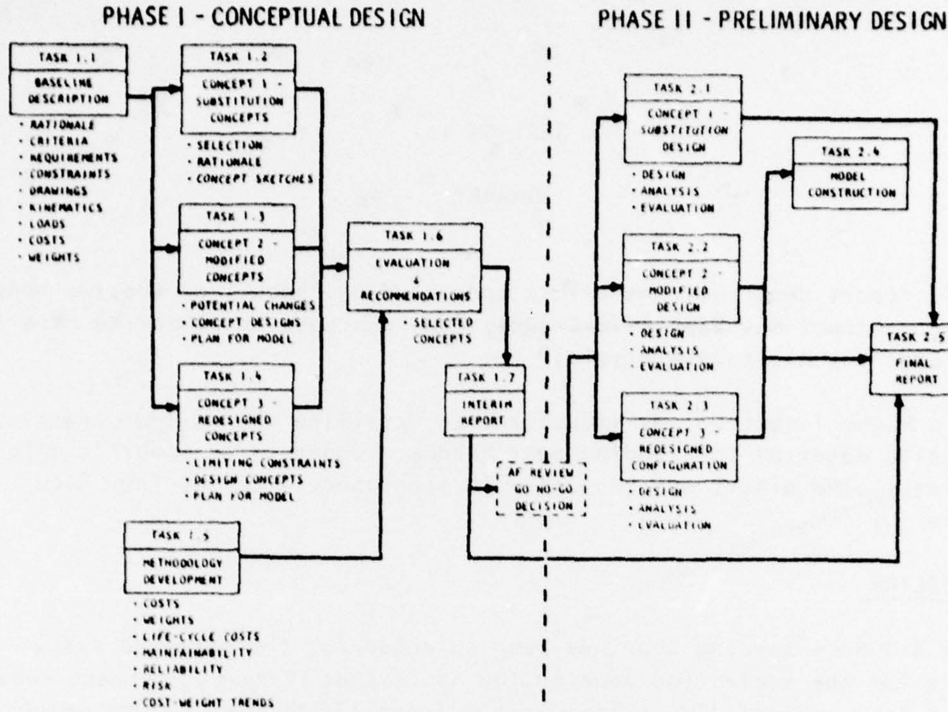


Figure 1. Task Flow Diagram

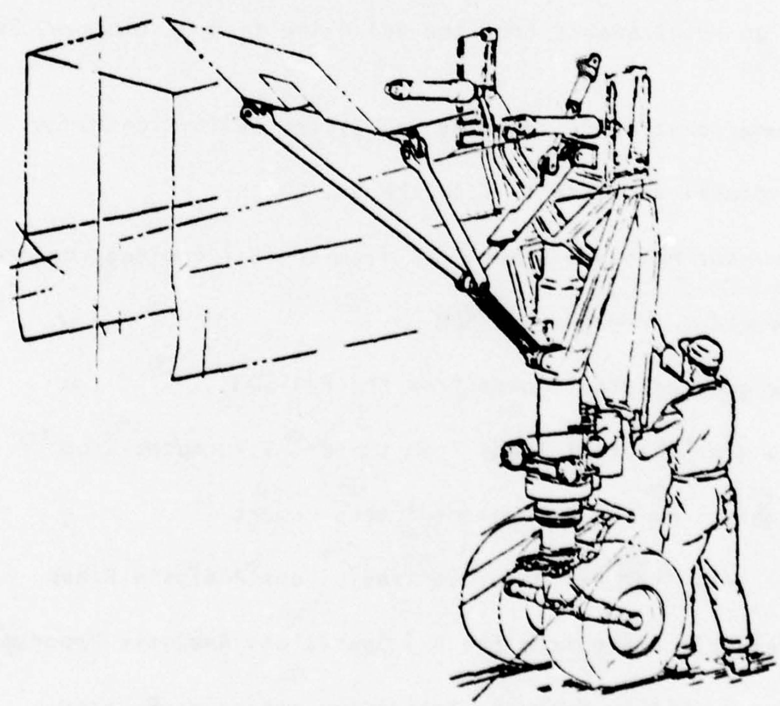


Figure 2. B-1 Nose Landing Gear

SECTION II

SUMMARY

This report describes the effort conducted on Phase I of the two-phase Air Force Contract ~~No. F33615-76-C-3021~~, "New Concepts in Composite Material Landing Gear for Military Aircraft."

This Phase I section was structured to determine the maximum practical use of composite material for landing gear hardware under three specific sets of constraints. The effort was conducted in accordance with the Task Flow Diagram of Figure 1.

2.1 BASELINE

The B-1 Nose Landing Gear has been selected for the baseline system and rationale for the seclection made on the basis that it meets contract requirements; it is a current Air Force airplane (over 175,000 lbs. gross weight) and is completely described by the information listed below:

1. Design criteria from MIL-A-8862
2. Design requirements from the B-1 Prime Item Development Specification
3. Volume constraints from the B-1 System Definition Manual (SDM)
4. Structural attachments from the B-1 SDM
5. Nose gear hardware dimensions from the B-1 Engineering drawings
6. Kinematics from the B-1 SDM
7. Nose gear external loads from the B-1 SDM
8. Nose gear internal loads from the B-1 Structures Group
9. Weights from the B-1 Weight Status report
10. Cost data from B-i Major Contracts Cost Analysis Group
11. Life-cycle costs from the B-1 Operations Analysis Program
12. Maintainability from the Integrated Logistics Program

13. Environmental data from the B-1 SDM

14. Reliability data from the B-1 Reliability Program

2.2 DESIGN CONCEPTS

The Design Concepts section of this program resulted in the selection of intermediate strength graphite/epoxy as the baseline composite material for use in the design studies. The three design sections included:

1. Substitution, constrained by form, fit and function;

2. Modified, constrained by fit and function, and

3. Redesigned, constrained by function only.

These designs were qualitatively evaluated by the experts in materials, structures, fabrication, weights and cost and a summary of these evaluations is presented in section VI, page 92. A summary of conclusions reached appears with the sections below.

2.2.1 Concept I - Substitution

Baseline information and drawings of B-1 nose gear metallic hardware was studied and conceptual design drawings were made for composite and composite/metal parts which have identical key dimensions, and can be substituted on a part-for-part basis for the baseline metallic hardware. Some of these concepts were designed to have composite material spliced to metallic end fittings to meet the high load requirements within the form constraint. Table I lists the parts designed in this section. All parts except the torque links (very high technical risk) are recommended for further effort in Phase II.

2.2.2 Concept 2 - Modified

Existing structural attachments were used, but kinematics of the drag braces and down lock links were revised to allow increased usage of composites. It was determined that for this concept the piston and the lower end of the strut cylinder must remain metallic since the larger diameter required for composite parts would result in having to spread the nose wheels and this would violate the stowage limit (fit) constraint. Table II lists the parts designed in this section. All listed parts are recommended for further effort in Phase II.

TABLE I

SUMMARY

CONCEPT I - SUBSTITUTION

PART	PART DESCRIPTION	REMARKS
Drag Brace - Fwd.	Composite tube with metal end fittings.	Recommended for Phase II
Drag Brace - Aft.	Composite "I" Beam with metal end fittings.	Same
Down Lock - Fwd.	Inverted "U" section all composite part.	Same
Down Lock - Aft.	Composite "I" section with one metal end fitting.	Same
Torque Link	All composite solid section	Very high technical risk. Part not recommended.
Strut-A-Trunnion Arms	Composite Trunnion Arms section including actuator arms bonded to metal strut	Very high technical risk. Part not recommended
Strut-B-Trunnion Arms	Two Composite Box section torque arms bolted to metal strut and actuator arms	Recommended for Phase II
Wheels	All composite. Two-piece dish shaped.	Same

TABLE II

SUMMARY

CONCEPT 2 - MODIFIED

PART	PART DESCRIPTION	REMARKS
Drag Brace - Fwd.	All composite box sections with "racetrack" caps.	Recommended for Phase II
Drag Brace - Aft	All composite box sections with "racetrack" caps.	Same
Spreader Bar-(Drag Brace)	Composite tube with metal end fittings.	Same
Down Lock - Fwd.	All composite "I" section with "racetrack" caps.	Same
Down Lock - Aft	All composite "I" section with "racetrack" caps.	Same
Torque Link	All composite-solid section No base lugs	Same
Strut-Trunnion Arms	Trunnion arms-flattened cone shape metal strut and actuator arms.	Same
Wheels	All composite 3-piece with rims and drum	Same

2.2.3 Concept 3 - Redesigned

Studies were made to evaluate the use of landing gear concepts which were allowed to differ from the baseline system in kinematics, attachment location and storage volume, see Table III. A "leaf"spring" concept, shown in figure 35 was evaluated as a very high technical risk and not weight effective. On that basis, effort on this concept was stopped. The size of the B-1 nose gear is an important factor against usage of this concept, but the "leaf spring" nose gear configuration may prove to be a viable weight effective system on a smaller fighter airplane.

TABLE III
SUMMARY

CONCEPT 3 - REDESIGNED

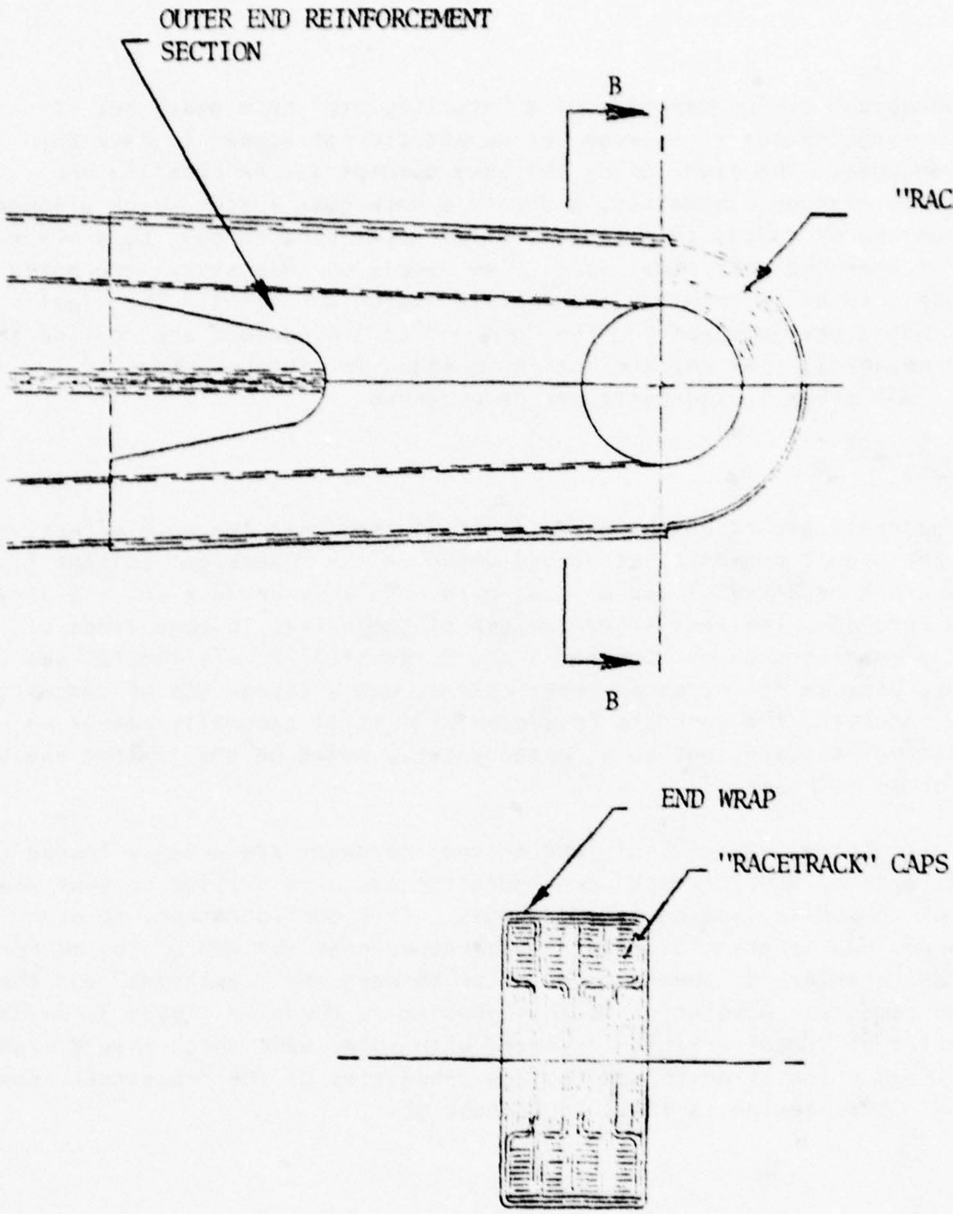
PART	PART DESCRIPTION	REMARKS
"Leaf Spring" Concept	Laminated composite leaves with resilient plastic inter-layers between leaves.	Very high technical risk - no weight advantage - not recommended.
Drag Brace - Fwd. (3-B Concept)	All composite "H" section with "racetrack" caps and stiffener clips.	Recommended for Phase II
Drage Brace - Aft (3-B Concept)	Same	Same
Spreader Bar (Drag Brace)	Composite tube and end fittings.	Same
Down Lock - Fwd.	All composite "I" section with "racetrack" caps.	Same
Down Lock - Aft	Same	Same
Torque Link	All composite with solid section and no lugs on base.	Same
Strut - Complete	Composite inner pressure cylinder, outer flattened cone shaped trunnion arms and lugs.	Same
Piston	Composite pressure cylinder and axle attach lugs.	Very high technical risk. Part not recommended.
Axle	Composite cylinder with metal wheel retainer.	Recommended for Phase II.
Wheel	All composite 2-piece with integral bolt spacers.	Same

A conceptual design was made of a "trailing arm" nose gear, but it requires a large change in storage volume and did not appear to have any major advantages. The study using the same concept as the baseline and only slightly changed kinematics, provided a nose gear system which allowed the maximum use of composite material while restricting changes to a minor widening of the nose gear wheel well. The wheels on this study were moved farther apart to allow room for a composite piston and strut. The "leaf spring" landing gear concept and the "piston" on 3-A concept are considered very high technical risk and are not recommended for further effort in Phase II. All other listed parts are recommended.

2.3 RESULTS

The general results of the Phase I effort show that the most effective gains in the use of composite structure occur in the "Redesign" Concept 3, section where more design freedom is allowed. This is because space limitations are removed which restrained the use of composites in some areas of the landing gear structure. Concept 1 and 2 resulted in more compromises in the design, because of increased restrictions, and a lesser use of composite structure; however, the concepts developed will still generally result in cost effective hardware, but to a lesser extent, based on the limited evaluation performed in Phase I.

Many structural elements of landing gear hardware are axially loaded and the weight effective "racetrack" configuration was used similar to that used in previous composite landing gear programs. This configuration, as previously used, has inherent structural weaknesses near the end of the member where large interlaminar shear forces occur between the "racetrack" and the web reinforcements. A solution to this problem is shown in figure 3, which uses a series of "racetracks" interleaved with shear webs which should significantly improve the strength and fatigue properties of the "racetrack" configuration. This design is shown in Concept 3b.



SECTION B - B

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"RACETRACK" CAPS & LAMINATED
REINFORCEMENT.

Figure 3. Structural Concept For Axially Loaded Struts

SECTION III

BASELINE

The B-1 nose landing gear installation consists of a semicantilevered shock strut with twin wheels and tires, a steering damping unit, and strut fairing doors. The shock strut is a dual chambered air-oil piston type. The forward retracting nose gear is attached to fuselage structural beams by a journaled trunnion at the top of the strut, and by a forward mounted folding drag brace. With the gear in the down and locked position, the drag brace is held in the on-center position by a jury strut downlock at the apex of the drag brace. A spring bungee holds the jury strut in its locked position. The nose gear strut incorporates a centering cam to center the nose wheels automatically and hold them centered while the shock strut is extended.

3.1 RATIONALE FOR SELECTION

The B-1 nose landing gear was selected as the baseline system for this program for the following reasons:

- The B-1 meets contract requirements for a baseline landing gear system.
- It is a current Air Force aircraft. Three aircraft are currently being flight tested, and production is expected to start late in 1976.
- The B-1 gross weight is 395,000 pounds which is over twice the contract minimum requirement of 175,000 pounds gross weight.
- The design requirements and constraints for the B-1 nose landing gear are available from the B-1 Prime Item Development Specification and the B-1 System Definition Manual.
- B-1 Division engineering drawings, layouts and vendor drawings are available to define the Air Vehicle (A/V) No. 4 nose landing gear hardware.
- The B-1 nose gear is relatively simple and provides a baseline system which can be readily handled within the scope of this program.
- Production of the B-1 nose gear for A/V No. 4 has not yet started, so changes as a result of this or possible follow-on programs could be implemented early in the production run.

- The B-1 contract is expected to reach a total of 240 aircraft, thus, cost savings in the nose gear could result in large total savings over the life of the program.

- The proximity of the B-1 design section makes the nose gear designers readily available for consultation.

- Cost and weight data for the baseline is readily available, and B-1 experts can be contacted for assistance on weight and cost estimates for the new hardware.

3.2 BASELINE DESCRIPTION

The data presented in this section completely describes all the design parameters and constraints which were used in the development of the current B-1 A/V No. 4 nose gear system design.

3.2.1 Design Criteria

The B-1 nose landing gear has been designed to comply with the landing and ground handling loads requirements of MIL-A-8862. This specification is not included with this report since it is readily available.

3.2.2 Design Requirements

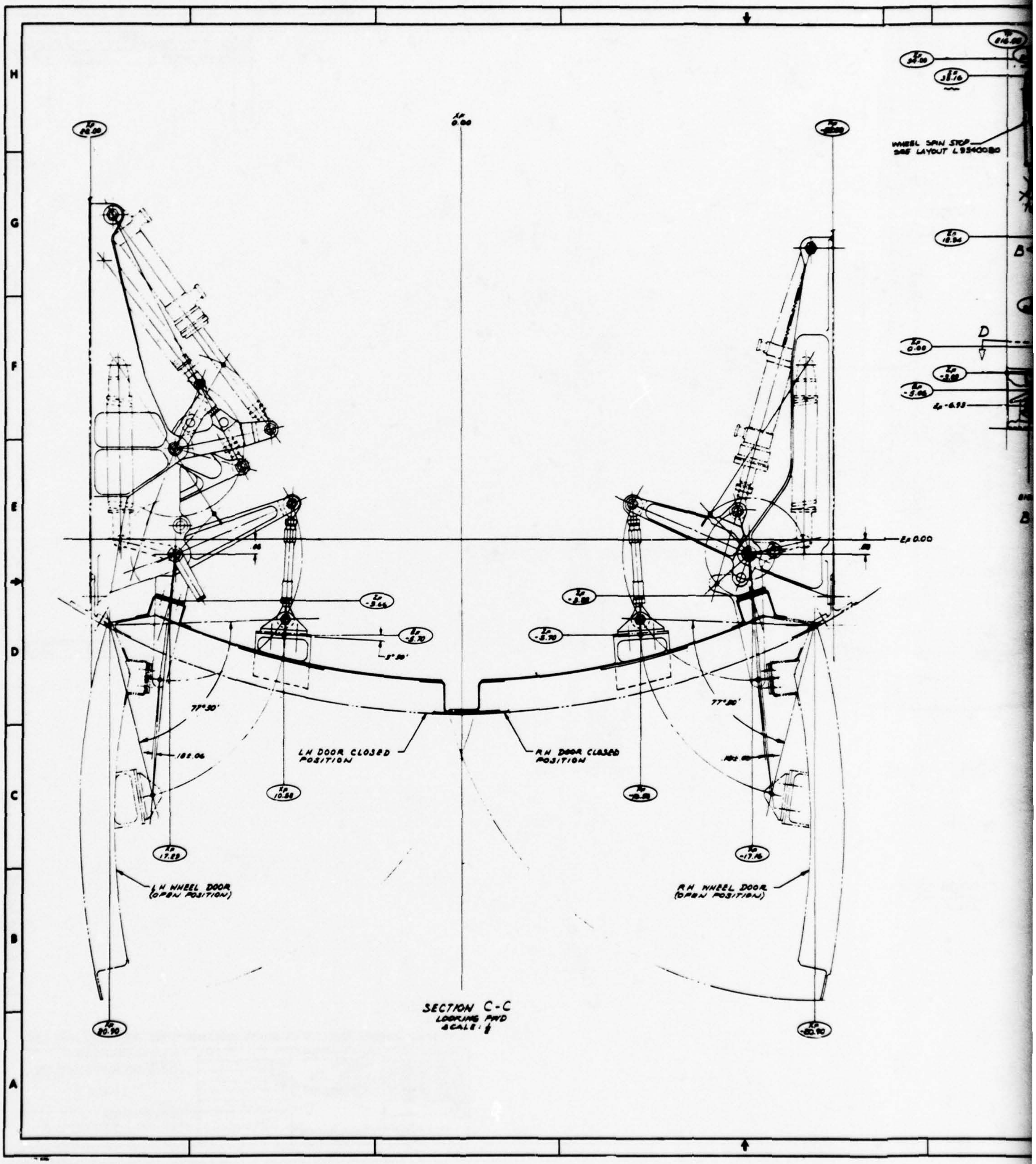
The B-1 design requirements from the Prime Item Development Specification (CP109L2001B) are presented in Appendix B.

3.2.3 Dimensional Constraints

The B-1 System Definition Manual (NA-69-190-2) describes the dimensional constraints associated with the nose gear system. The volume constraints, structural attachments and kinematics are shown on drawing L9340068, sheets 1, 2 and 3 (figures 4, 5, and 6).

3.2.4 Metallic Hardware Dimensions

Dimensions of the A/V No. 4 metallic nose gear hardware are given on: B-1 Engineering drawings; L3400308, sheets 1 and 2, L3400311, sheets 1 and 2 (figures 7, 8, 9, and 10); layout L9340074 (figure 11); Menasco drawing 3002600, sheets 1 and 2; and 3002602 (figures 12, 13 and 14), and 3002687, sheets 1 and 2 (figures 15 and 16); and on Goodyear drawing PD 2661, sheets 1 and 2 (figures 17 and 18).



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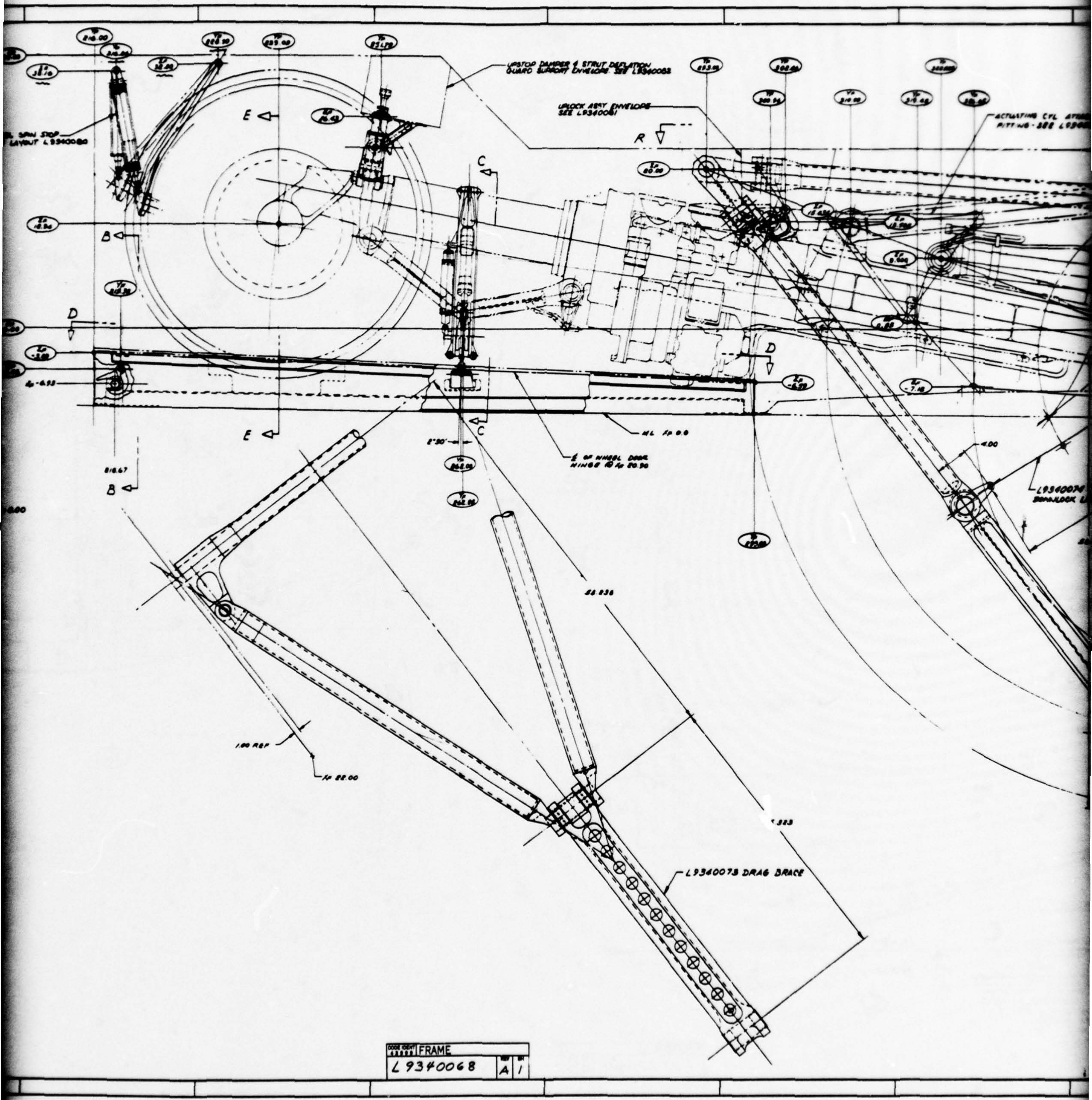
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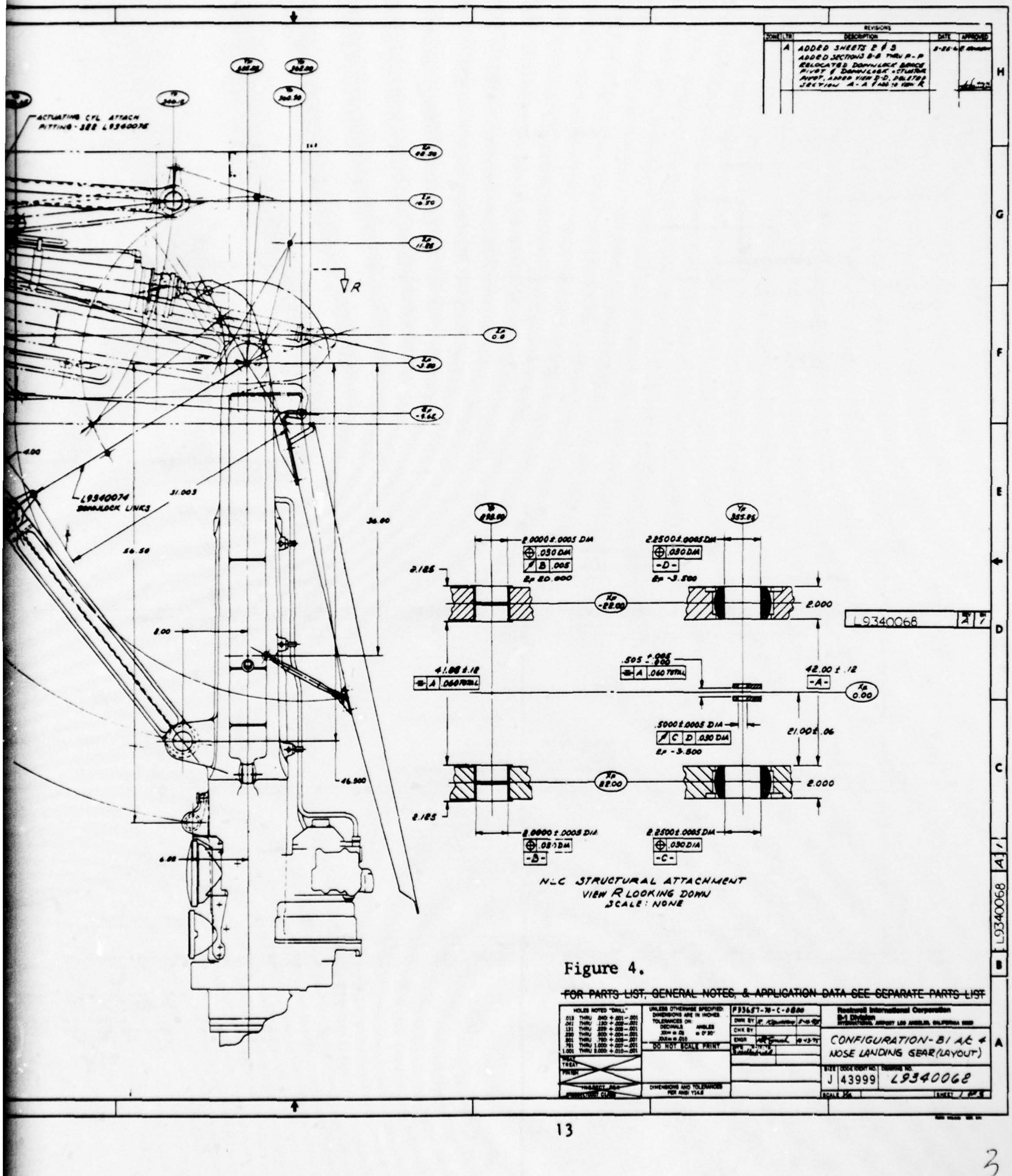
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Figure 4.

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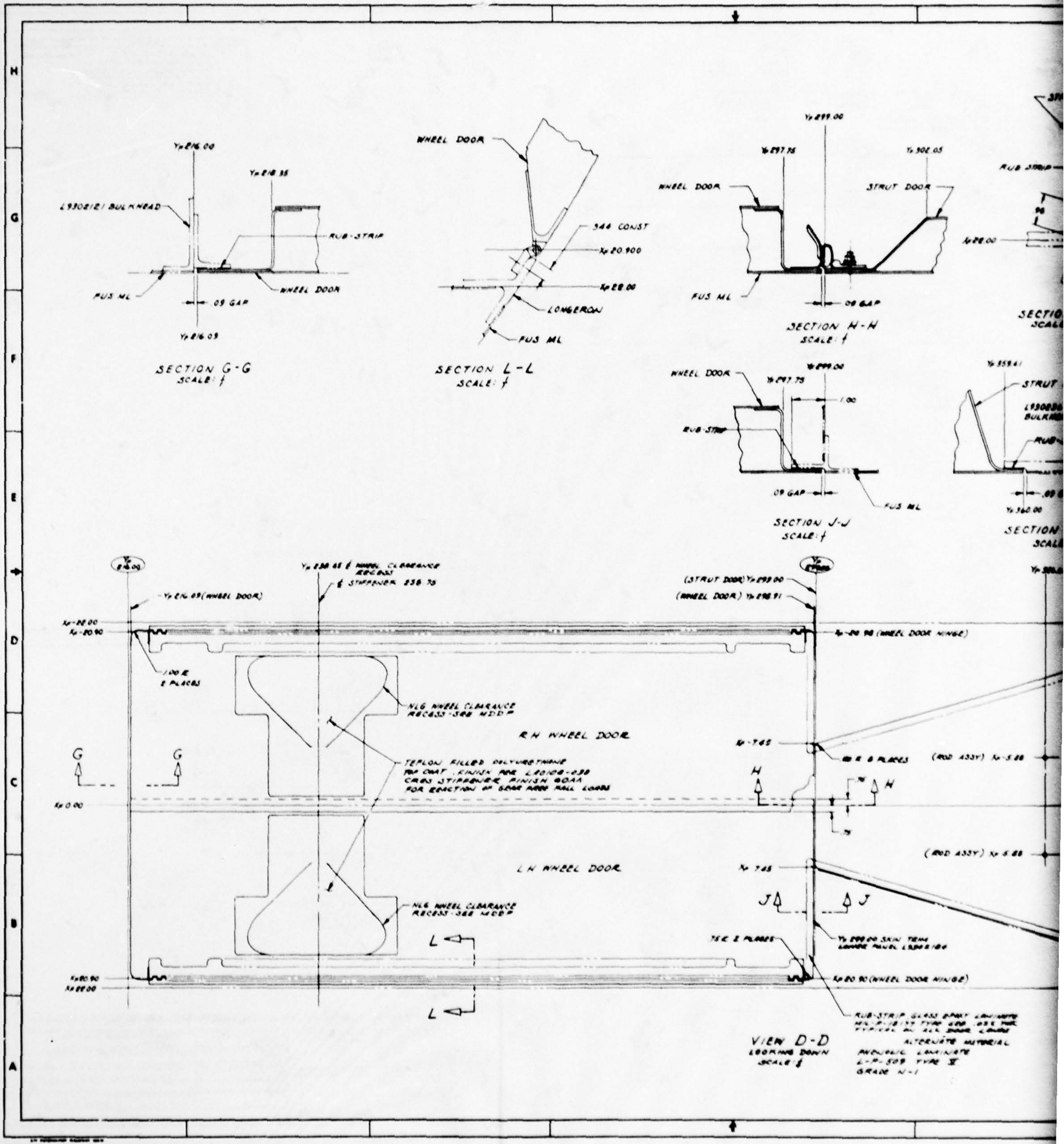
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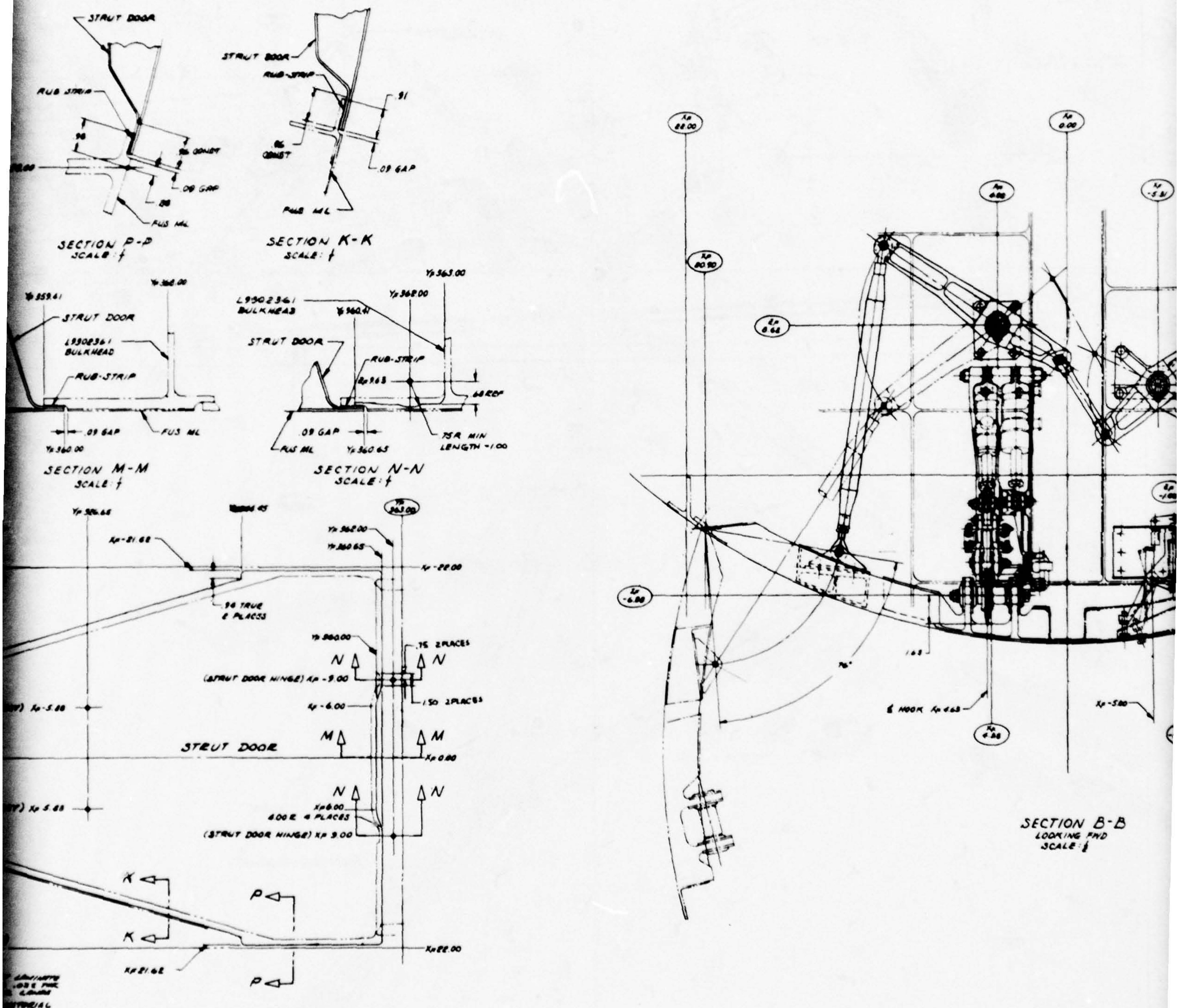

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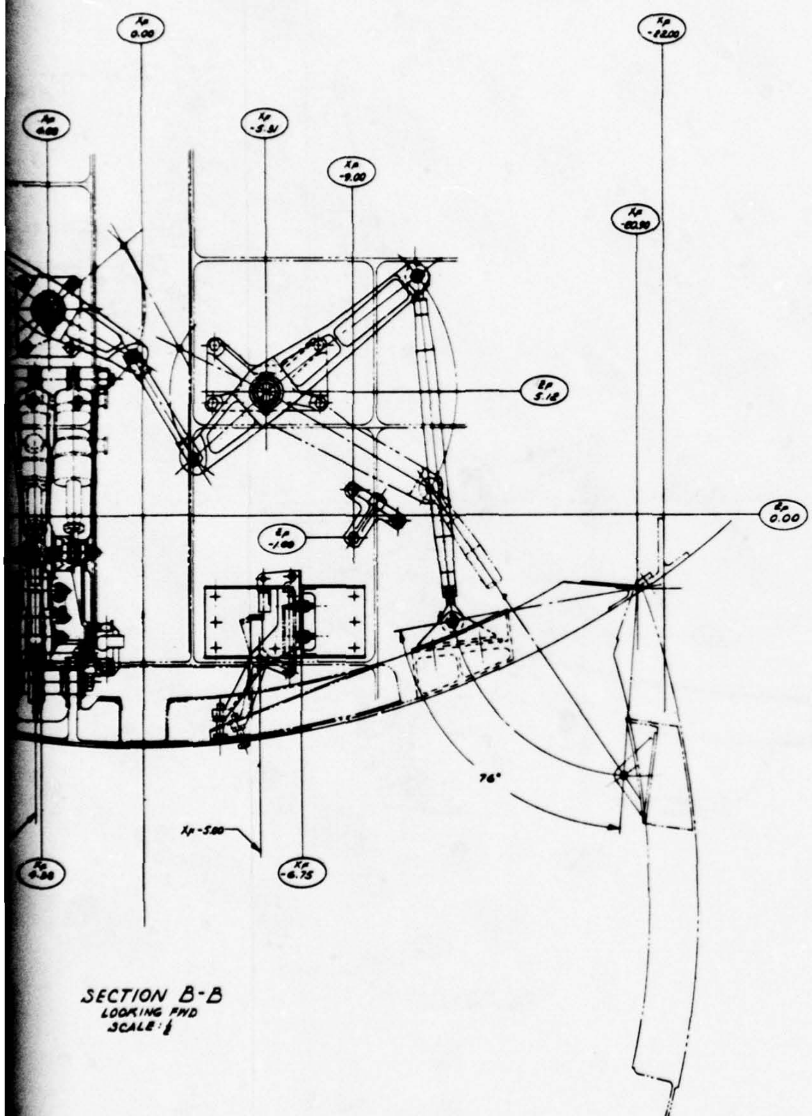

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Figure 5.

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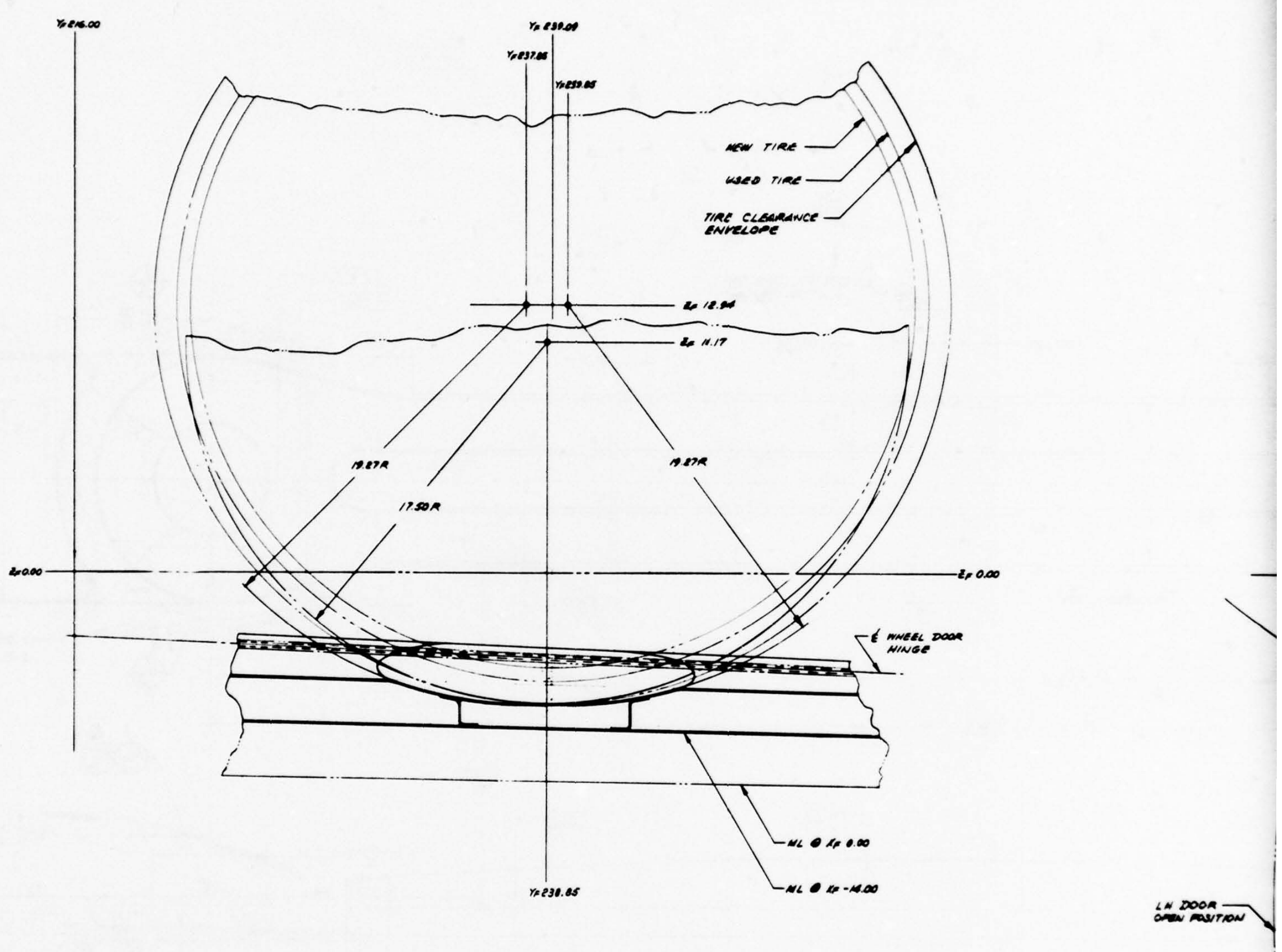

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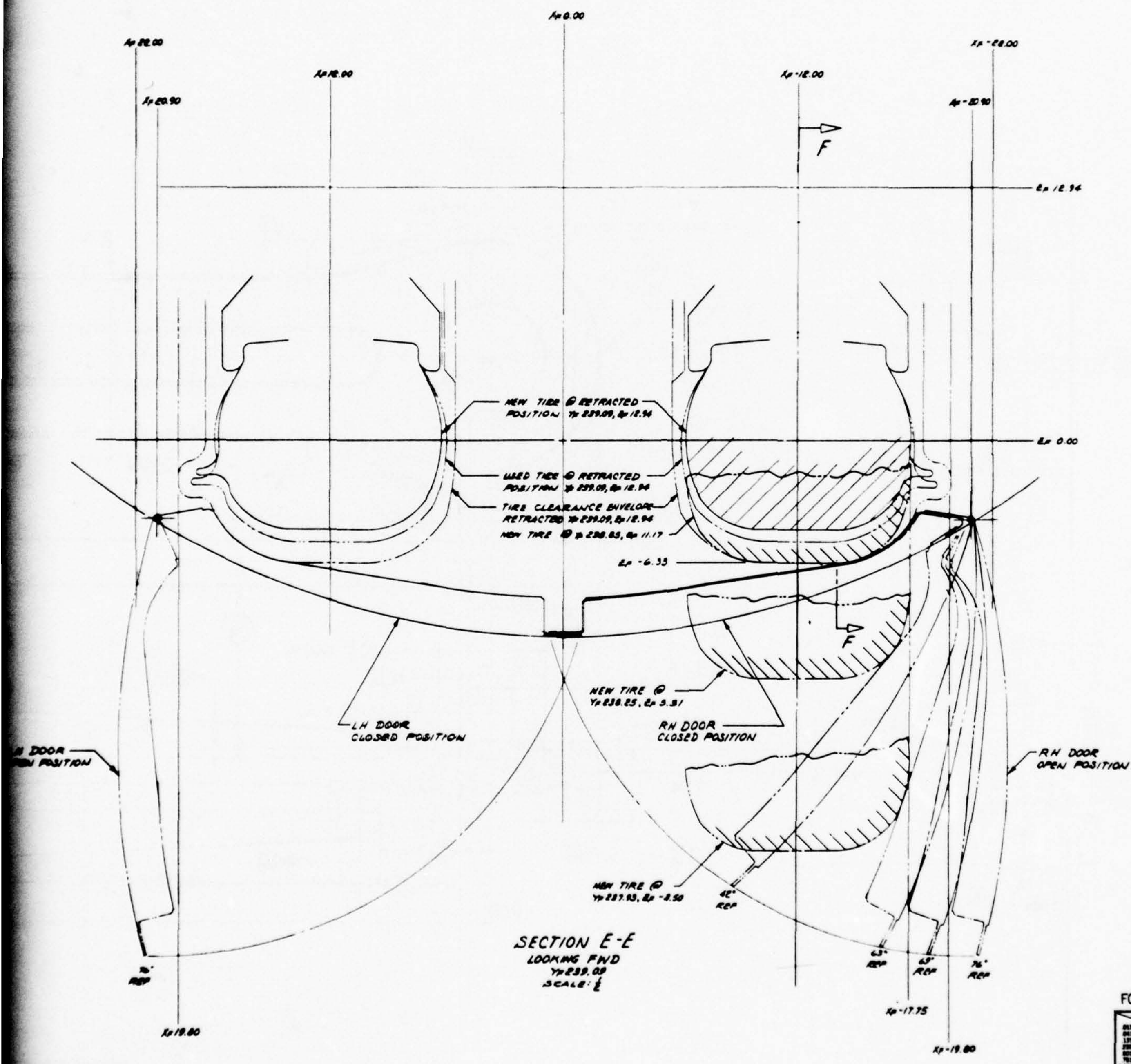

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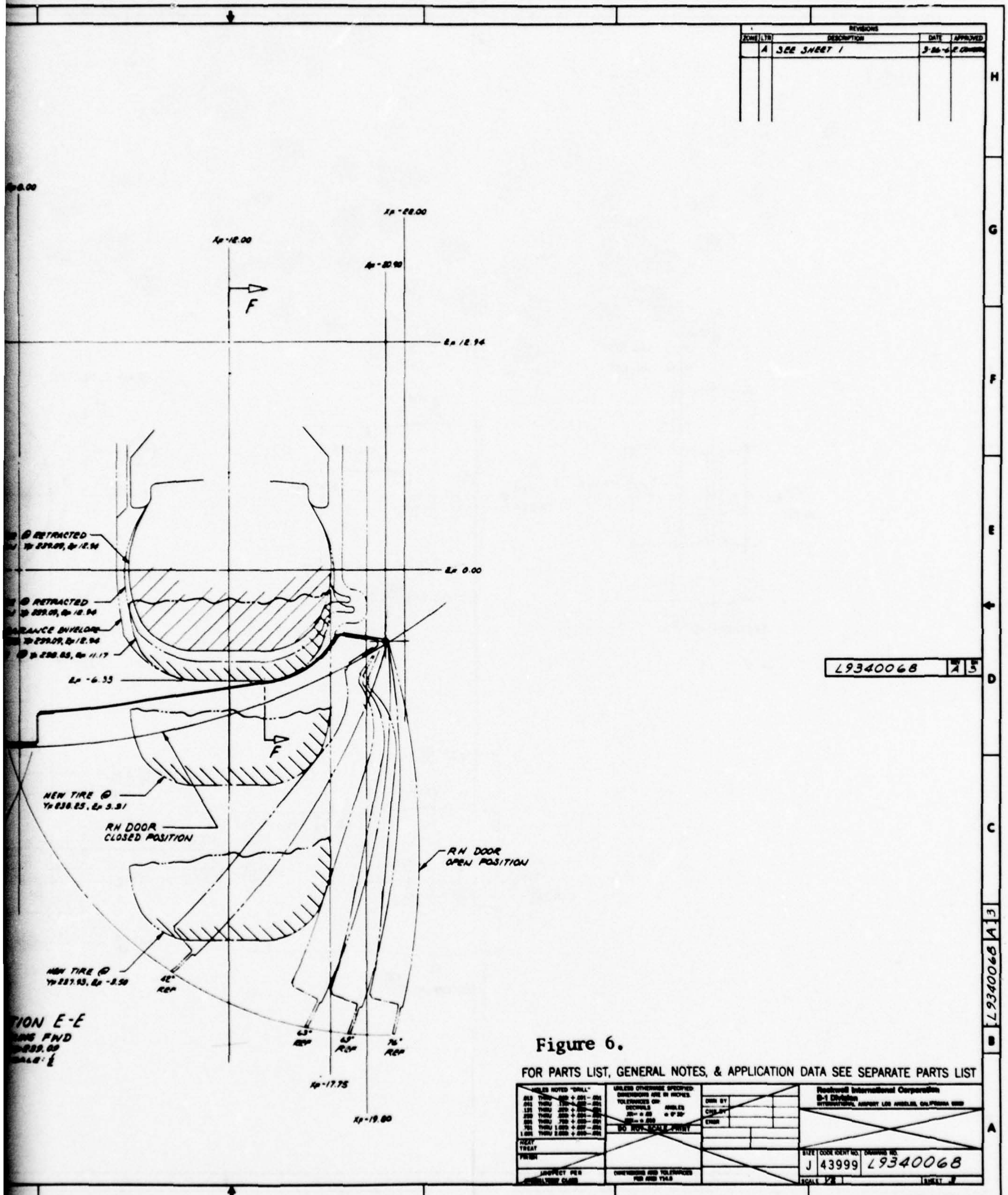

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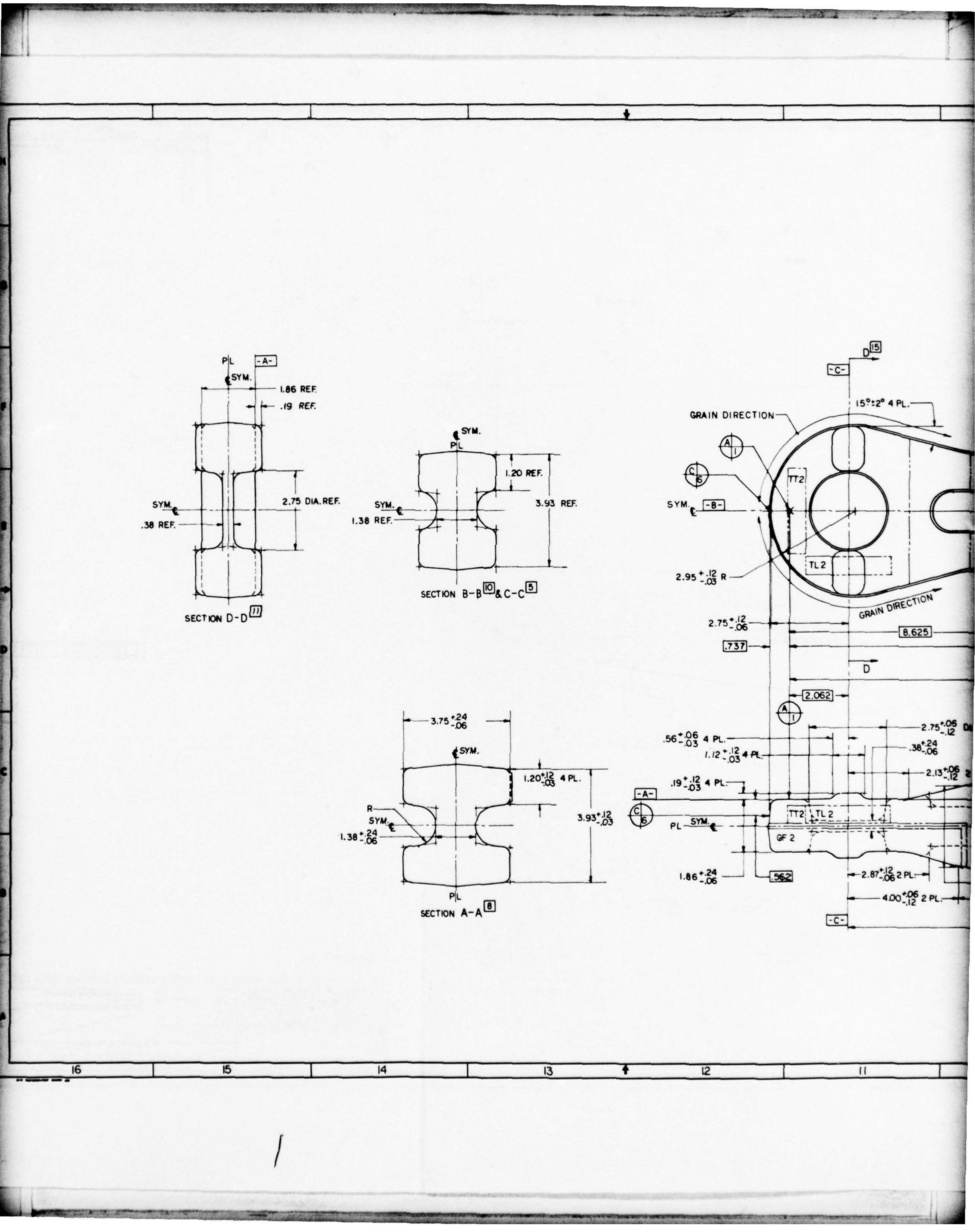
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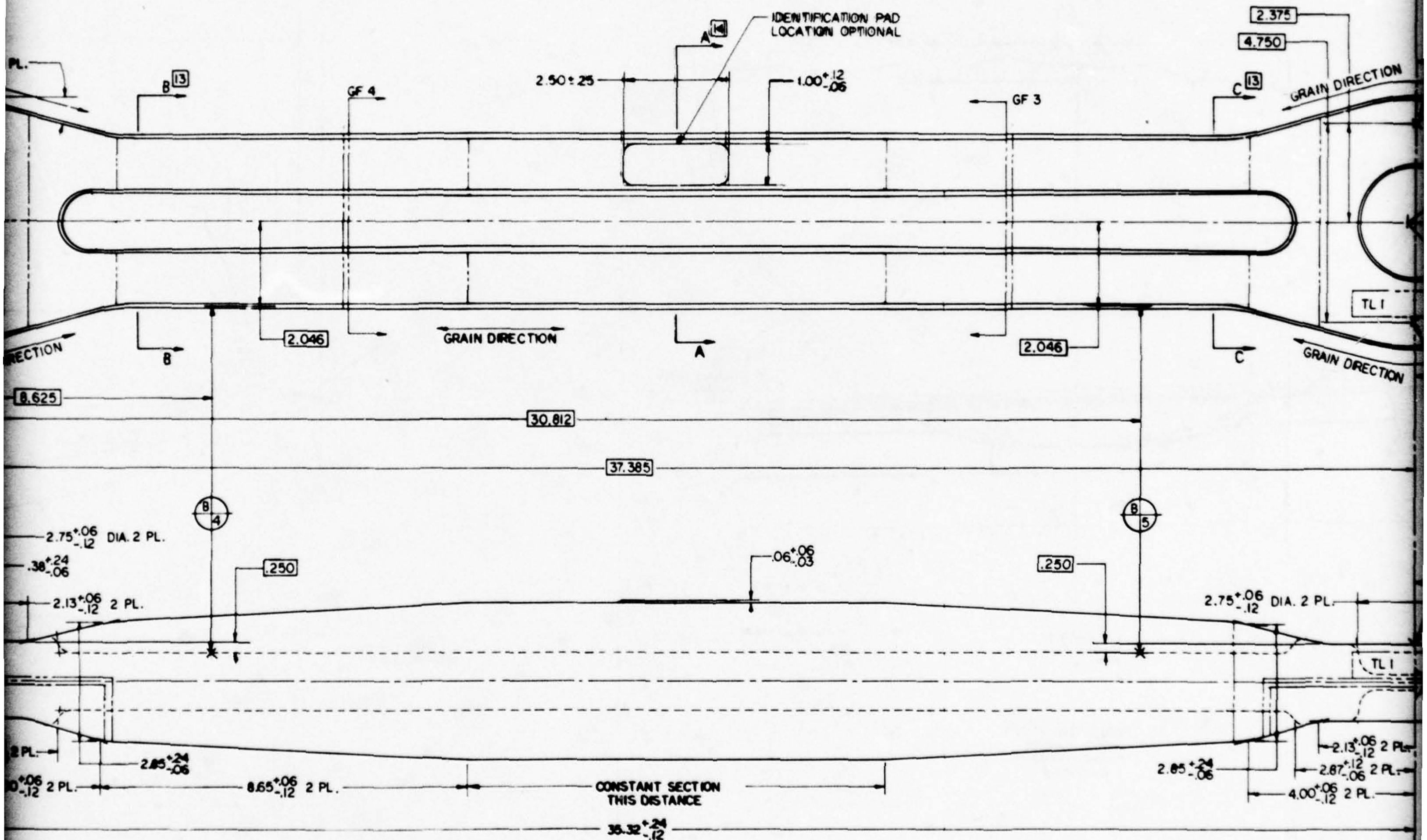
3.93 +.12 -.03
1.38 +.24 -.06
GRAIN DIRECTION
15° ±2° 4 PL.
2.95 +.12 -.03 R
2.75 +.12 -.06
.737
8.625
2.062
.56 +.06 -.03 4 PL.
1.12 +.12 -.03 4 PL.
.19 +.12 -.03 4 PL.
1.86 +.24 -.06
.562
2.87 +.12 -.06 2 PL.
4.00 +.06 -.12 2 PL.
2.75 +.05 -.12
.38 +.24 -.06
2.13 +.06 -.12
TT2
TL 2
GF 2
SYM.
PL
16
15
14
13
12
11



-003 FORGING

FRAME		
L3400308		1

10	9	8	7	6	5

2

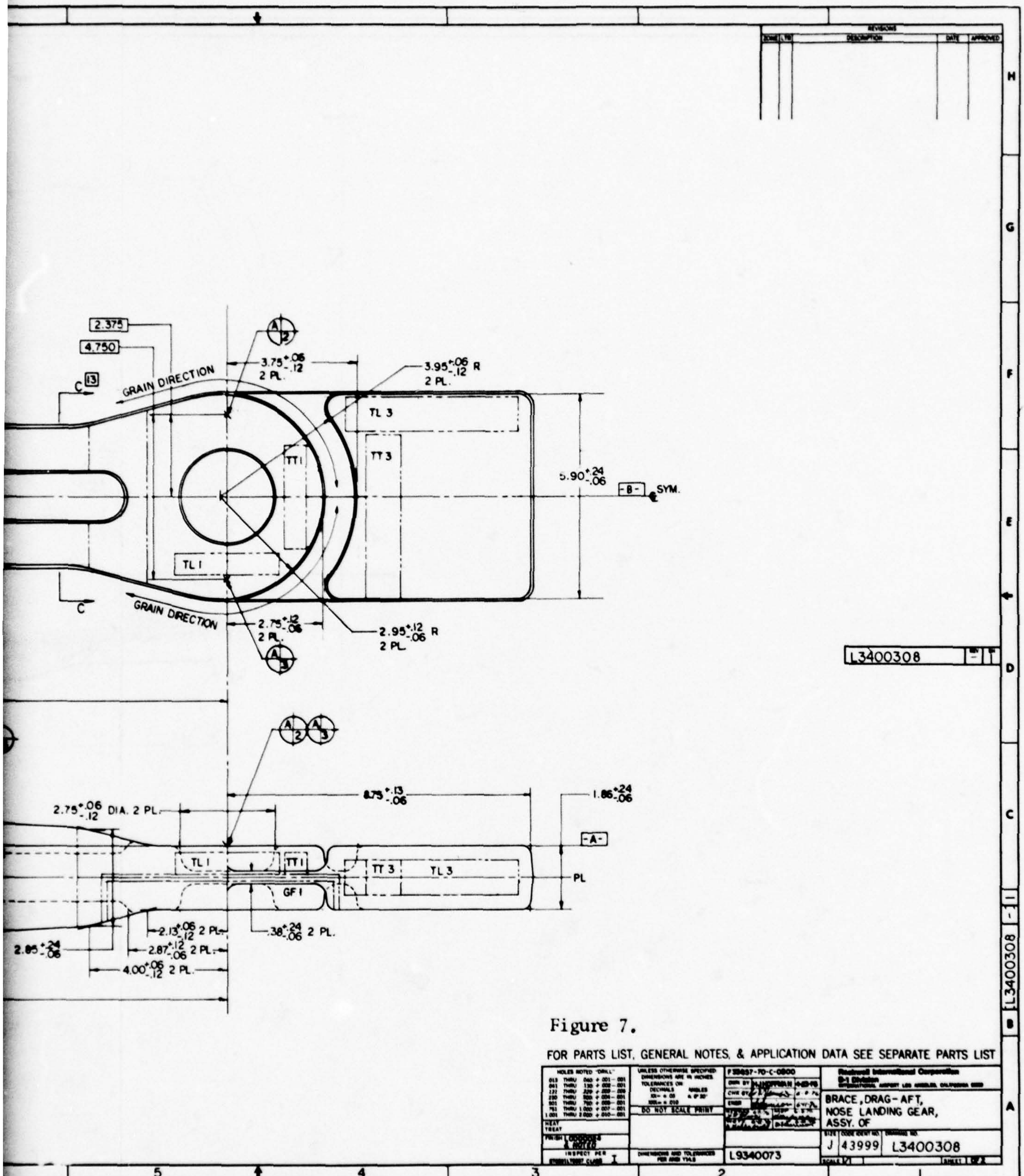
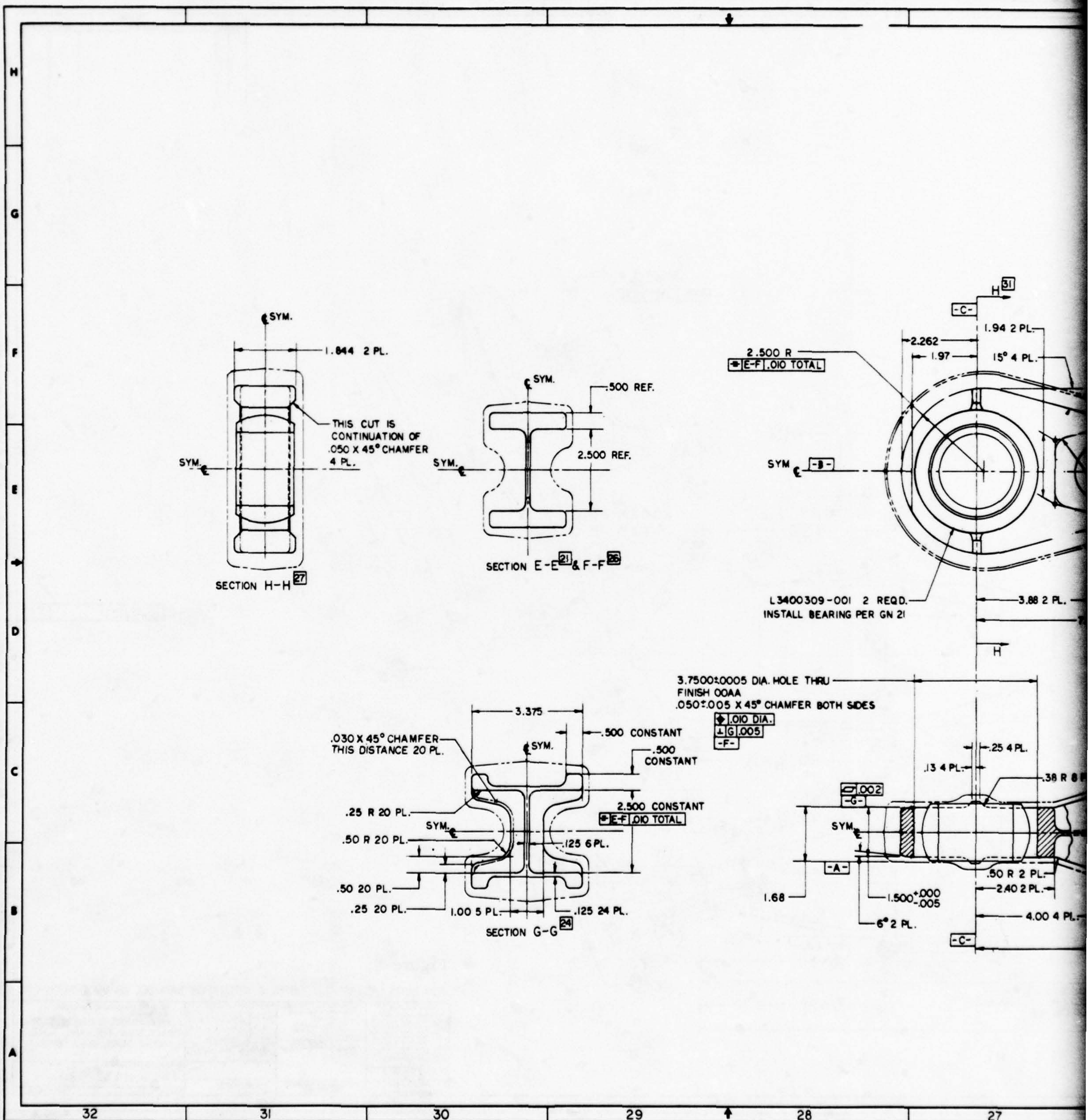
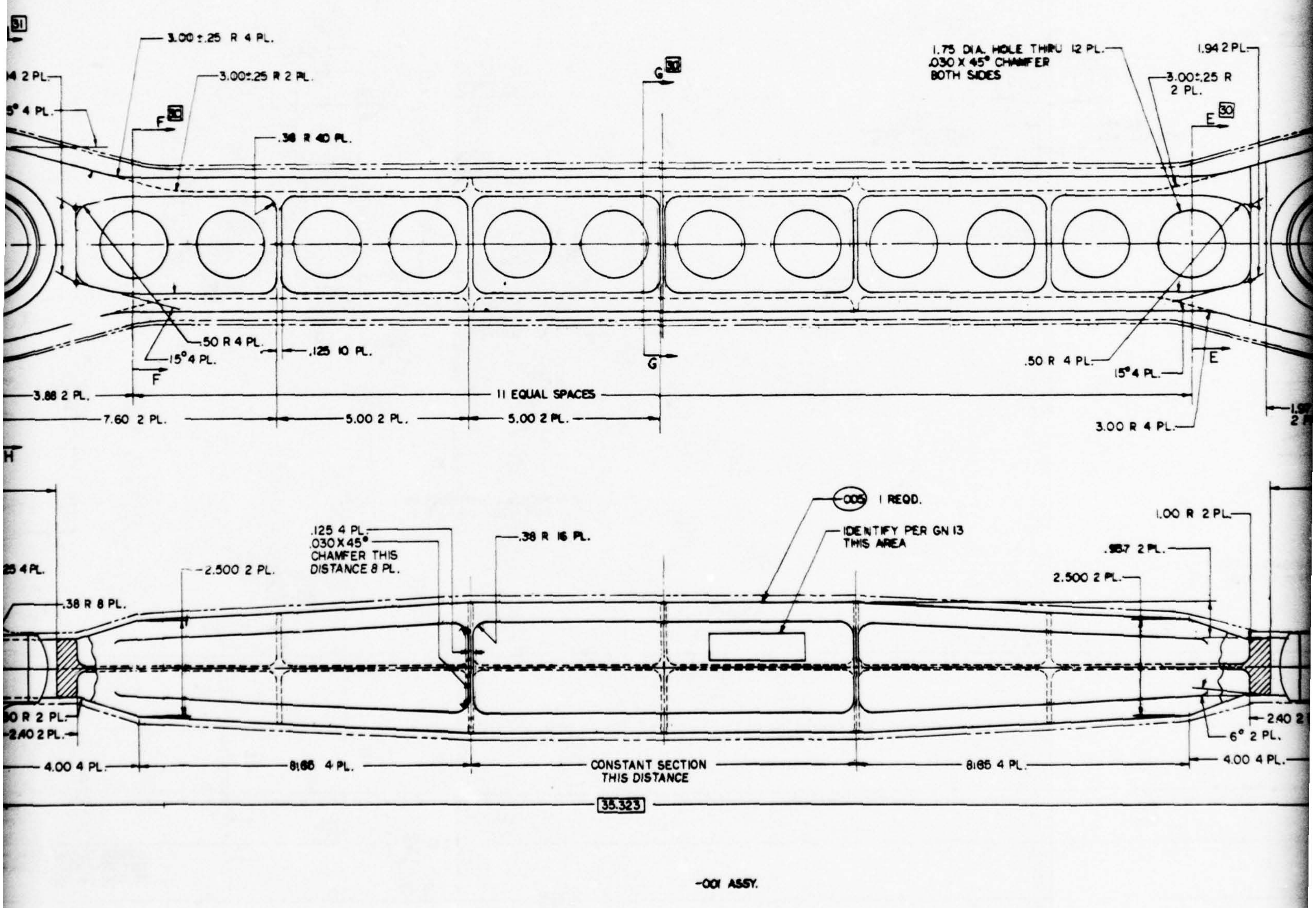

REVISIONS
ZONE
LTR
DESCRIPTION
DATE
APPROVED
H
G
F
E
D
C
B
A
2.375
4.750
GRAIN DIRECTION
C 13
3.75 +.06 -.12 2 PL.
3.95 +.06 -.12 R 2 PL.
TL 3
TT 3
TT 1
TL 1
5.90 +.24 -.06
-B-
SYM.
2.75 +.12 -.06 2 PL.
2.95 +.12 -.06 R 2 PL.
L3400308
8.75 +.13 -.06
1.86 +.24 -.06
2.75 +.06 -.12 DIA. 2 PL.
-A-
PL
GF 1
2.13 +.06 -.12 2 PL.
.38 +.24 -.06 2 PL.
2.85 +.24 -.06
2.87 +.12 -.06 2 PL.
4.00 +.06 -.12 2 PL.
FOR PARTS LIST, GENERAL NOTES, & APPLICATION DATA SEE SEPARATE PARTS LIST
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
DO NOT SCALE PRINT
Rockwell International Corporation
B-1 Division
BRACE, DRAG-AFT, NOSE LANDING GEAR, ASSY. OF
J
43999
L3400308
L9340073
5
4
3
2
1

Figure 7.

3



SYM.
1.844 2 PL.
THIS CUT IS CONTINUATION OF .050 X 45° CHAMFER 4 PL.
SYM.
SECTION H-H 27
SYM.
.500 REF.
2.500 REF.
SYM.
SECTION E-E 21 & F-F 26
H 31
-C-
1.94 2 PL.
2.262
1.97
15° 4 PL.
2.500 R
E-F .010 TOTAL
SYM -B-
L3400309-001 2 REQD.
INSTALL BEARING PER GN 21
3.88 2 PL.
H
3.7500±.0005 DIA. HOLE THRU
FINISH OOAA
.050±.005 X 45° CHAMFER BOTH SIDES
.010 DIA.
G .005
-F-
3.375
.030 X 45° CHAMFER THIS DISTANCE 20 PL.
.500 CONSTANT
SYM.
.500 CONSTANT
2.500 CONSTANT
E-F .010 TOTAL
.25 R 20 PL.
SYM.
.50 R 20 PL.
.125 6 PL.
.50 20 PL.
.25 20 PL.
1.00 5 PL.
.125 24 PL.
SECTION G-G 24
.25 4 PL.
.13 4 PL.
.38 R 8
.002
-G-
SYM.
-A-
.50 R 2 PL.
2.40 2 PL.
1.68
1.500 +.000 -.005
6° 2 PL.
4.00 4 PL.
-C-
H
G
F
E
D
C
B
A
32
31
30
29
28
27



FRAME

L3400308 | 2

27 | 26 | 25 | 24 | 23 | 22 | 21

2

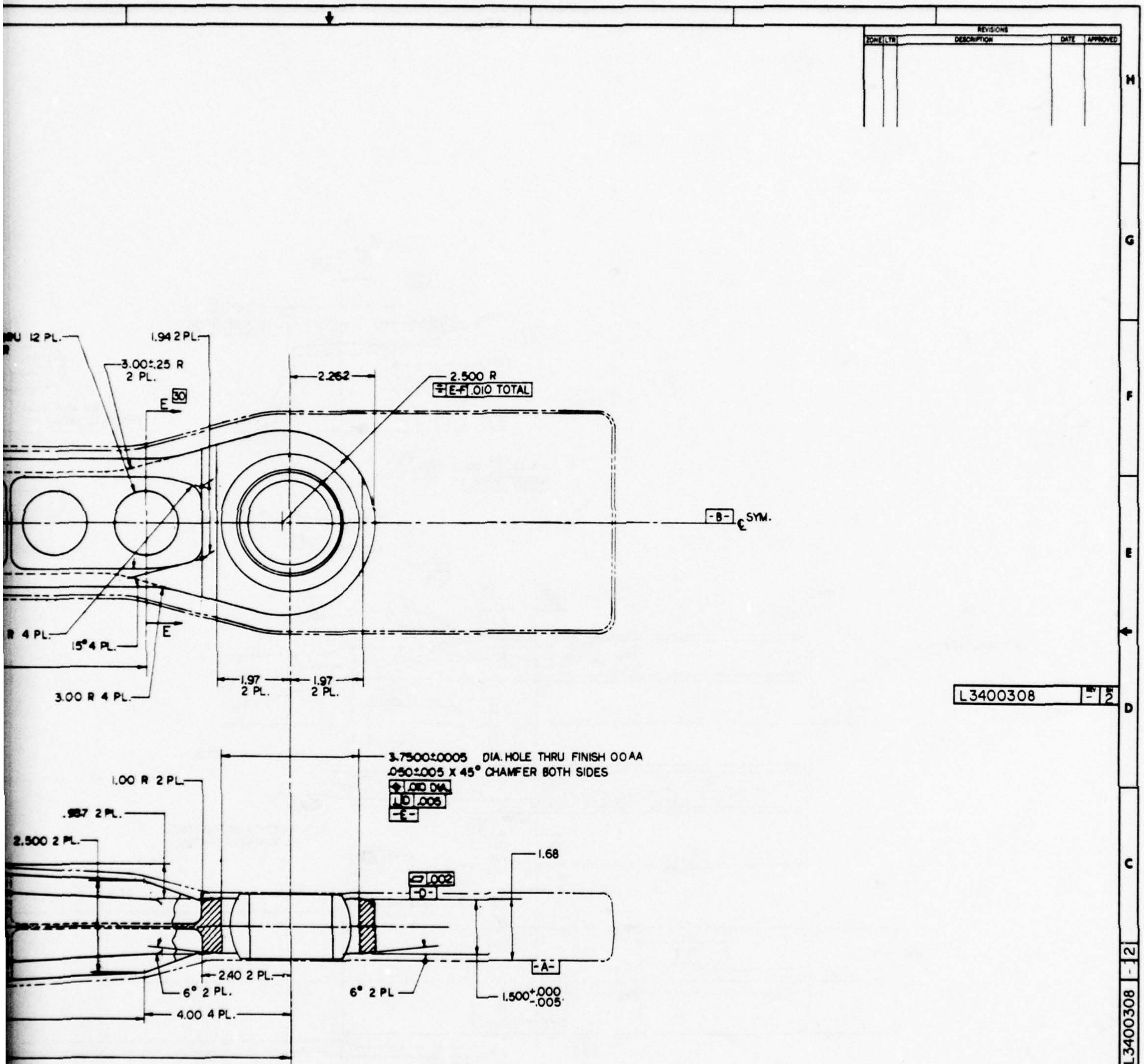


Figure 8.

FOR PARTS LIST, GENERAL NOTES, & APPLICATION DATA SEE SEPARATE PARTS LIST

DO NOT SCALE PRINT

F33657-70-C-0800

DWN BY H. HOFFMAN

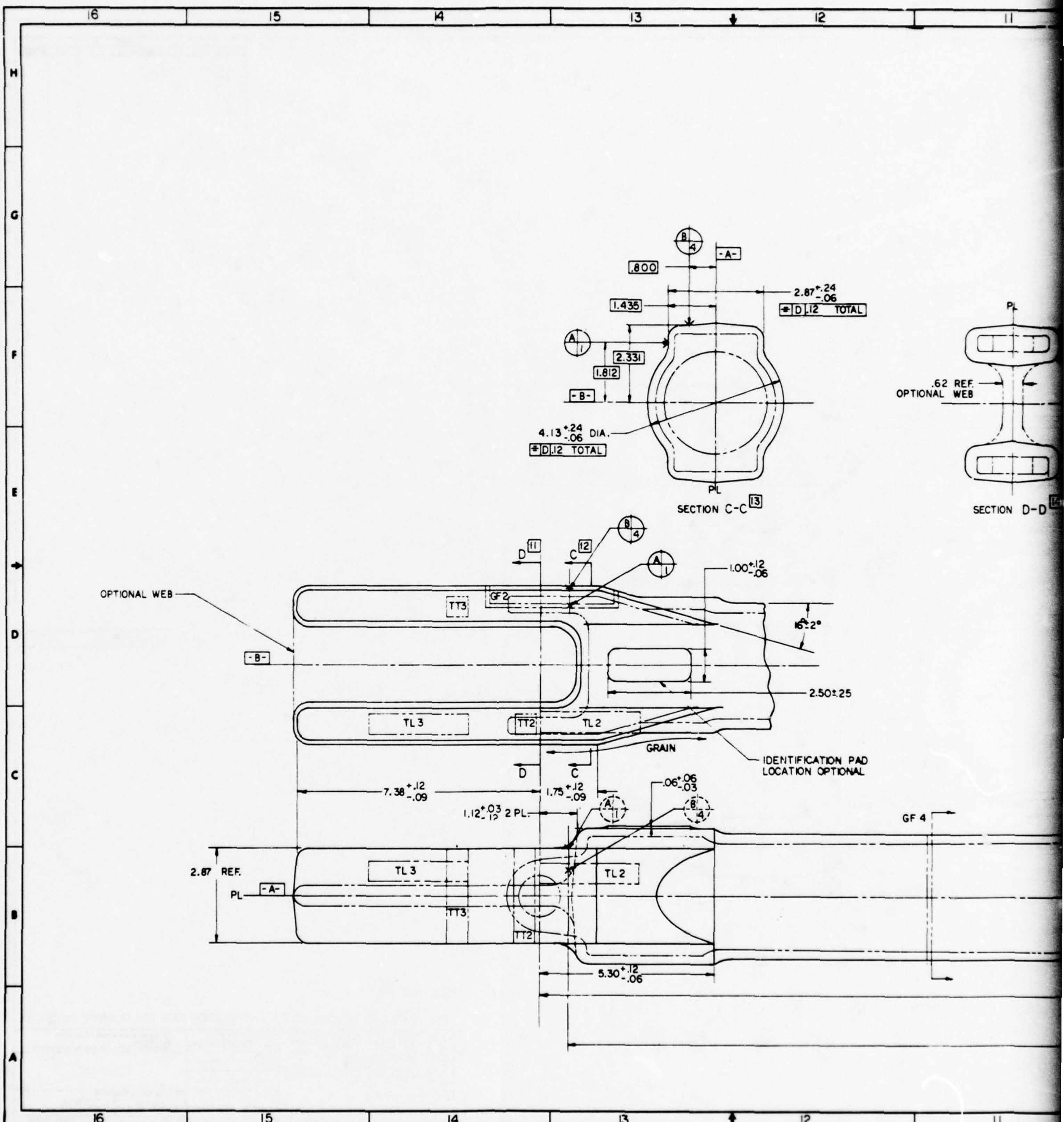
Rockwell International Corporation
B-1 Division

SIZE J CODE IDENT NO. 43999 DRAWING NO. L3400308

SCALE 1/1 SHEET 2 OF 2

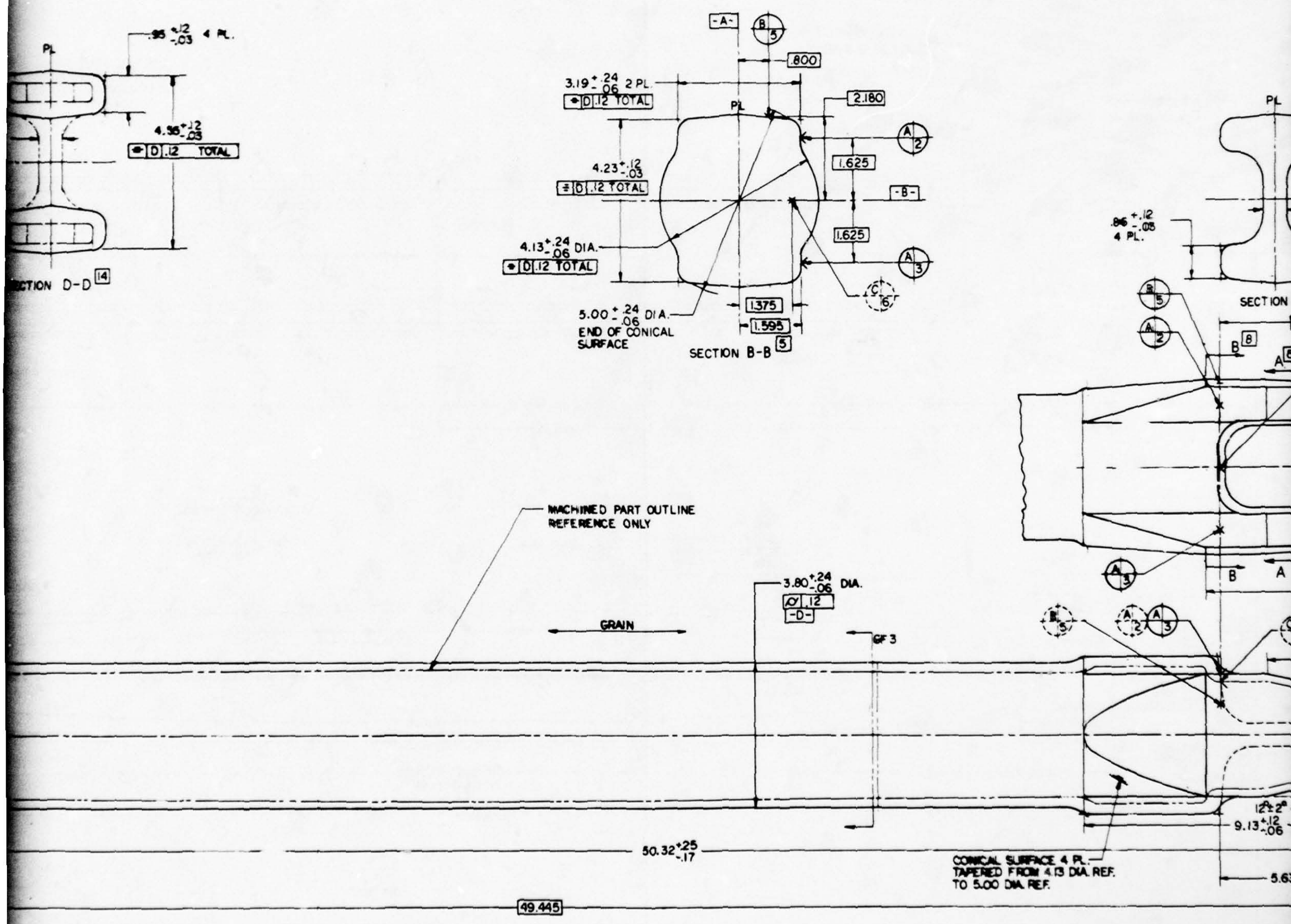
21 20 19 18 17

3



16
15
14
13
12
11
H
G
F
E
D
C
B
A
-A-
.800
1.435
2.87 +.24 -.06
D .12 TOTAL
2.331
1.812
-B-
4.13 +.24 -.06 DIA.
D .12 TOTAL
PL
SECTION C-C 13
.62 REF.
OPTIONAL WEB
SECTION D-D 14
D 11
C 12
1.00 +.12 -.06
OPTIONAL WEB
TT3
GF2
16° ± 2°
-B-
2.50 ± .25
TL 3
TT2
TL 2
GRAIN
IDENTIFICATION PAD
LOCATION OPTIONAL
D
C
7.38 +.12 -.09
1.75 +.12 -.09
.06 +.06 -.03
1.12 +.03 -.12 2 PL.
GF 4
2.87 REF.
PL
-A-
TL 3
TL 2
TT3
TT2
5.30 +.12 -.06

11 10 9 8 7 6



-003 FORGING

FRAME	
L3400311	1

11 10 9 8 7 6

2

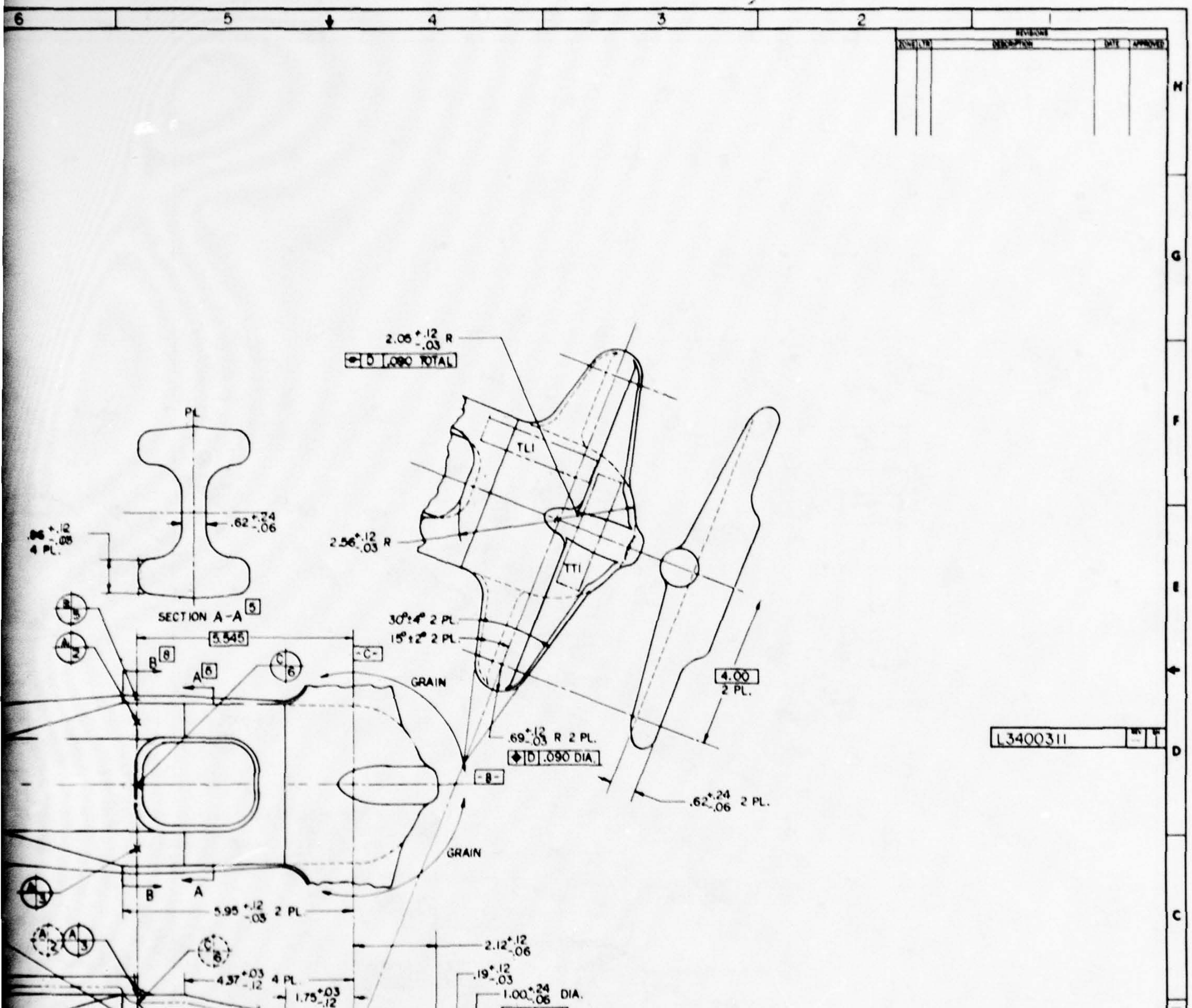
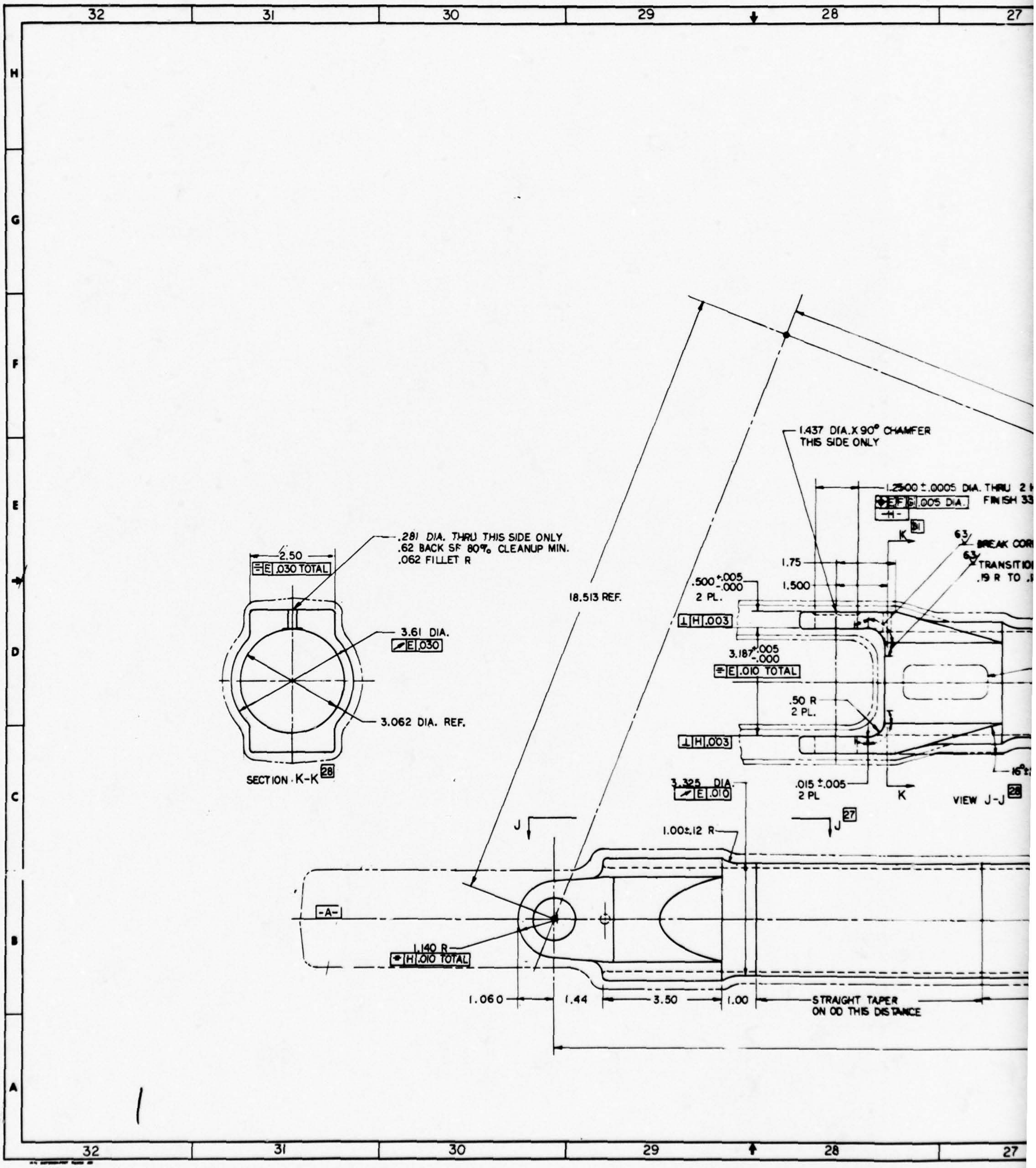


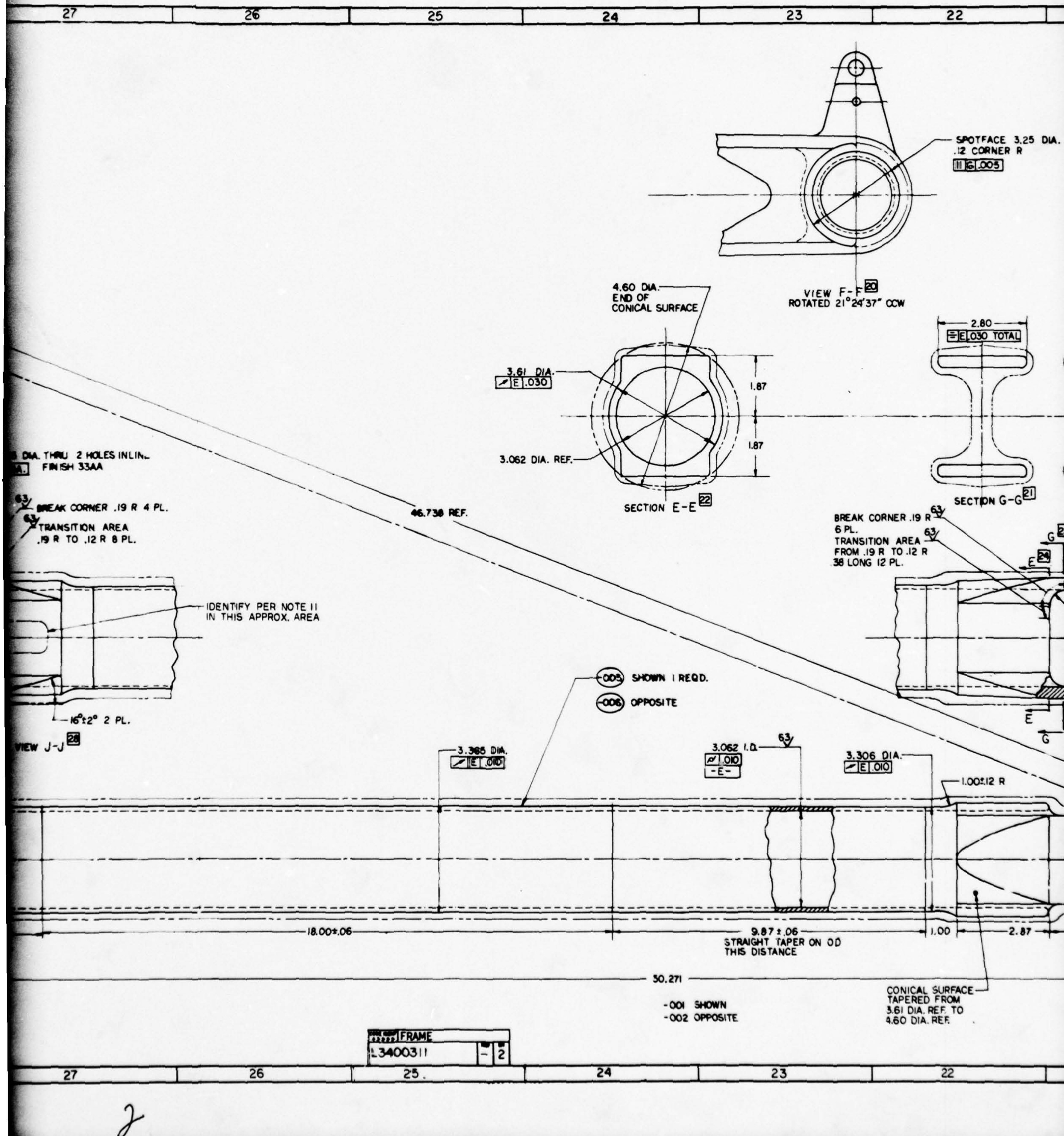
Figure 9.

FOR PARTS LIST, GENERAL NOTES, & APPLICATION DATA SEE SEPARATE PARTS LIST

3



32
31
30
29
28
27
H
G
F
E
D
C
B
A
.281 DIA. THRU THIS SIDE ONLY
.62 BACK SF 80% CLEANUP MIN.
.062 FILLET R
2.50
.030 TOTAL
3.61 DIA.
E .030
3.062 DIA. REF.
SECTION K-K 28
18.513 REF.
1.437 DIA. X 90° CHAMFER
THIS SIDE ONLY
1.2500 ±.0005 DIA. THRU 2
FINISH 33
.005 DIA.
-H-
BREAK COR
TRANSITIO
.19 R TO
1.75
1.500
.500 +.005 -.000
2 PL.
H .003
3.187 +.005 -.000
E .010 TOTAL
.50 R
2 PL.
.015 ±.005
2 PL
K
VIEW J-J 28
3.325 DIA.
E .010
J
27
1.00±.12 R
-A-
1.140 R
H .010 TOTAL
1.060
1.44
3.50
1.00
STRAIGHT TAPER
ON OD THIS DISTANCE



27
26
25
24
23
22
SPOTFACE 3.25 DIA.
.12 CORNER R
.005
VIEW F-F 20
ROTATED 21°24'37" CCW
4.60 DIA.
END OF
CONICAL SURFACE
3.61 DIA.
E .030
1.87
1.87
3.062 DIA. REF.
SECTION E-E 22
2.80
E .030 TOTAL
SECTION G-G 21
DIA. THRU 2 HOLES INLINE
FINISH 33AA
BREAK CORNER .19 R 4 PL.
TRANSITION AREA
.19 R TO .12 R 8 PL.
46.738 REF.
BREAK CORNER .19 R
6 PL.
TRANSITION AREA
FROM .19 R TO .12 R
.38 LONG 12 PL.
IDENTIFY PER NOTE 11
IN THIS APPROX. AREA
-005 SHOWN 1 REQD.
-006 OPPOSITE
16°±2° 2 PL.
VIEW J-J 28
3.366 DIA.
E .010
3.062 I.D.
.010
-E-
3.306 DIA.
E .010
1.00±.12 R
18.00±.06
9.87±.06
STRAIGHT TAPER ON OD
THIS DISTANCE
1.00
2.87
30.271
-001 SHOWN
-002 OPPOSITE
CONICAL SURFACE
TAPERED FROM
3.61 DIA. REF. TO
4.60 DIA. REF.
FRAME
L3400311
2

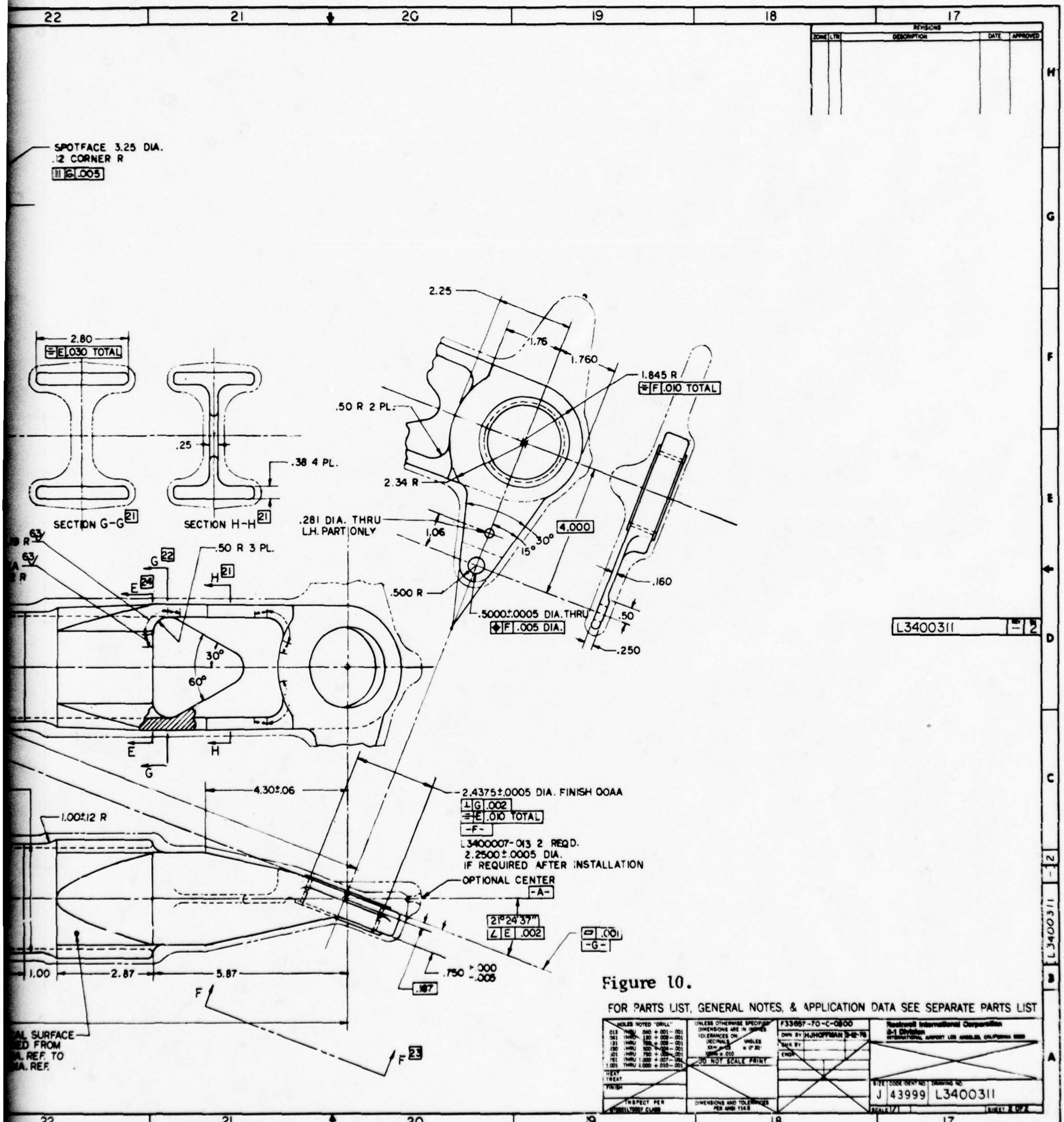
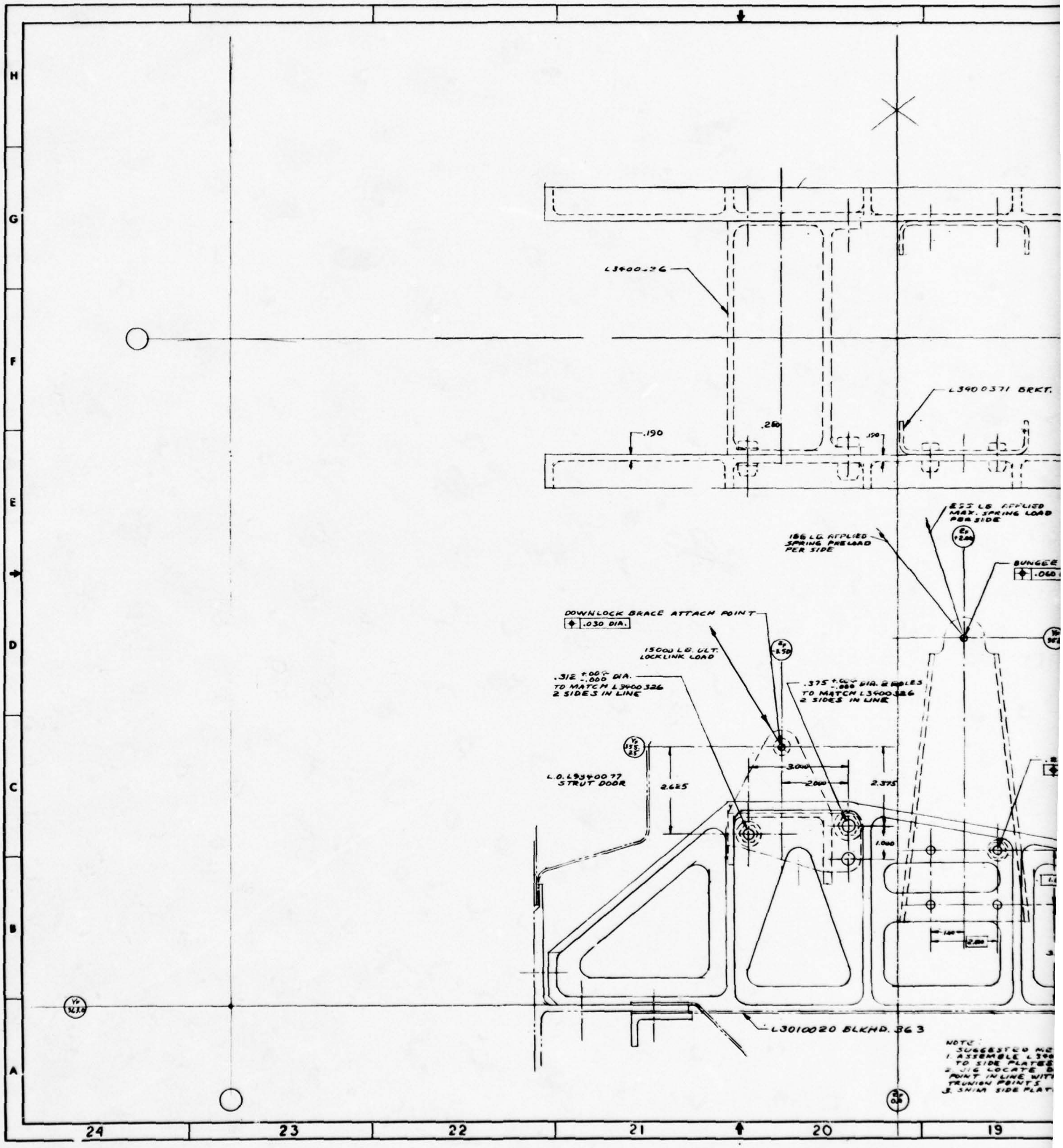


Figure 10.

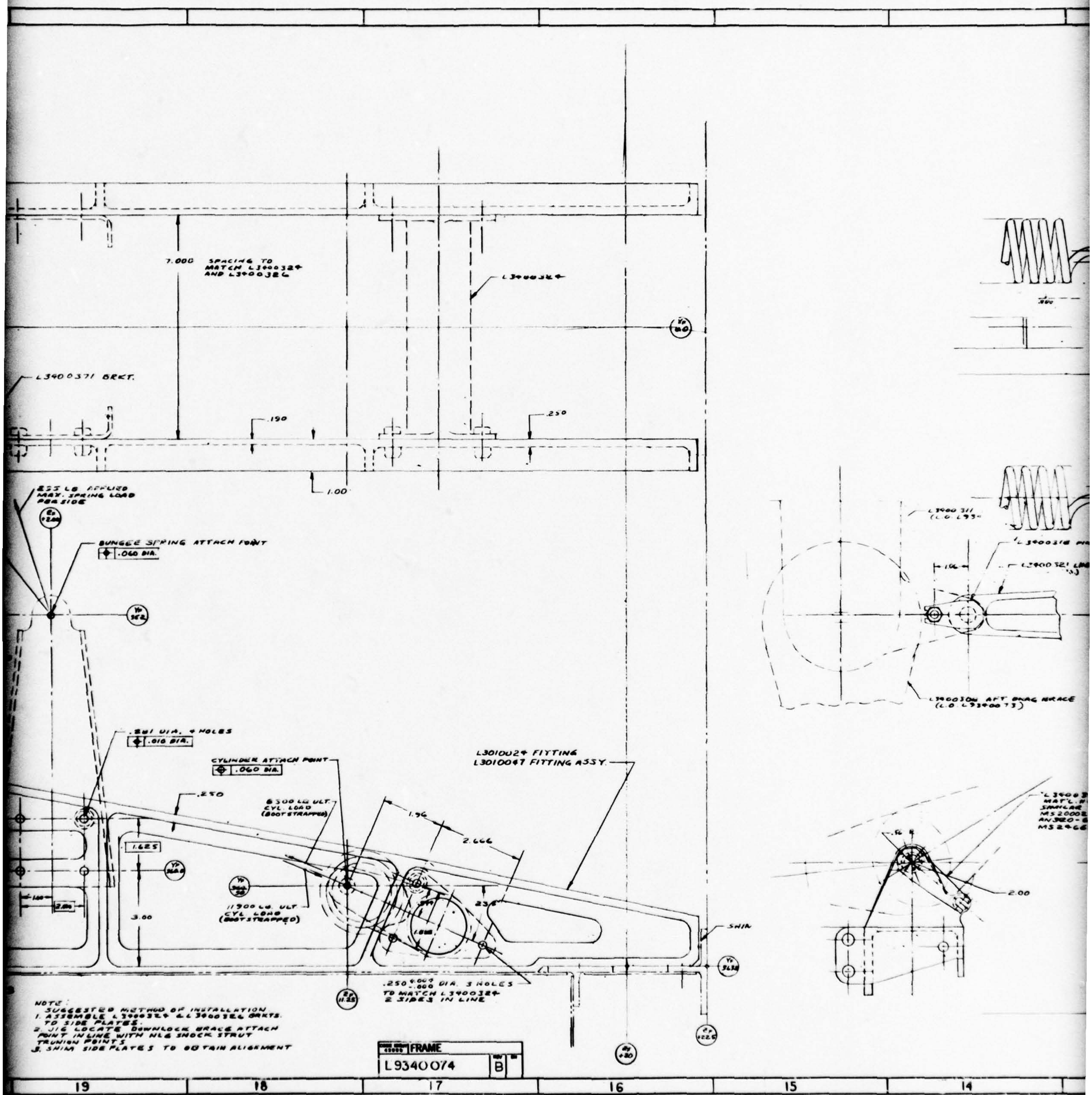
FOR PARTS LIST, GENERAL NOTES, & APPLICATION DATA SEE SEPARATE PARTS LIST

3



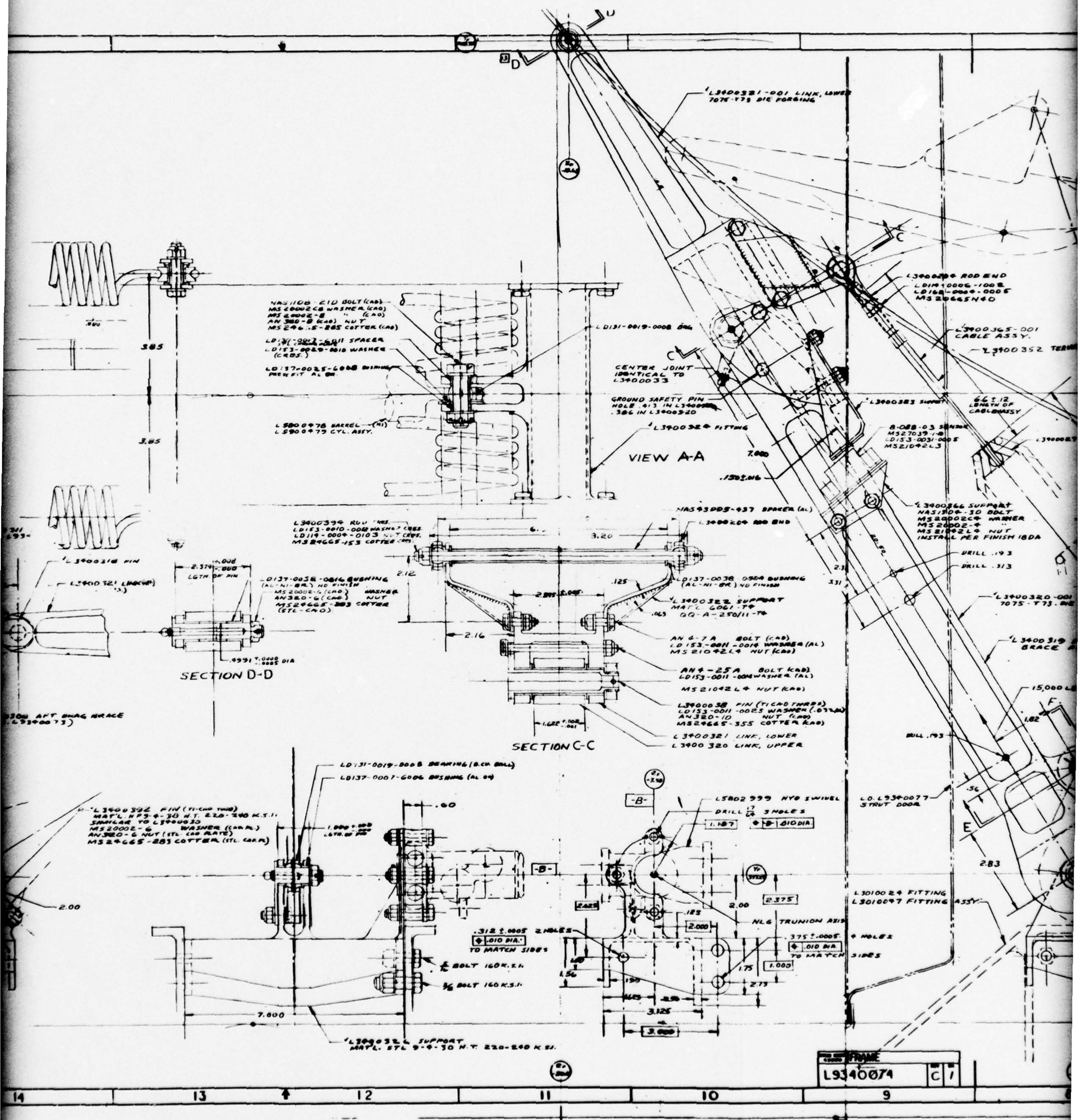
L3400326
L3400371 BRKT.
.190
.250
.190
255 LB APPLIED MAX. SPRING LOAD PER SIDE
186 LB APPLIED SPRING PRELOAD PER SIDE
BUNGEE
.060
DOWNLOCK BRACE ATTACH POINT
.030 DIA.
15000 LB. ULT. LOCKLINK LOAD
.312 +.005 -.000 DIA. TO MATCH L3400326 2 SIDES IN LINE
.375 +.005 -.000 DIA. 2 HOLES TO MATCH L3400326 2 SIDES IN LINE
L.O. L9340077 STRUT DOOR
2.625
3.000
2.000
2.375
1.000
L3010020 BLKHD. 363
NOTE:
SUGGESTED
1. ASSEMBLE
TO SIDE PLATES
2. JIG LOCATE
POINT IN LINE WIT
TRUNION POINTS
3. SHIM SIDE PLAT

1



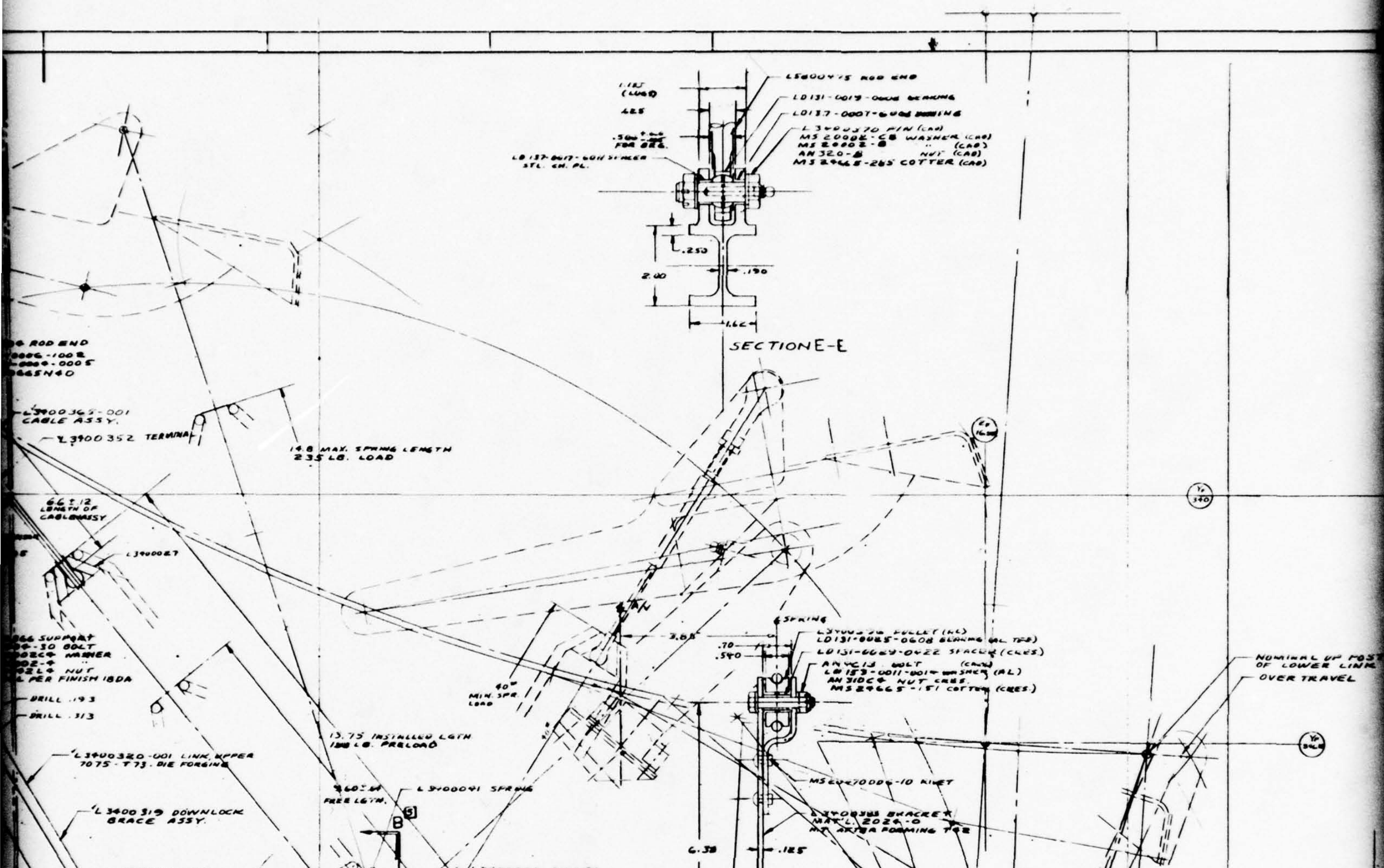
7.000 SPACING TO MATCH L3400324 AND L3400326
L3400324
L3400371 BRKT.
.190
.250
1.00
235 LB APPLIED MAX. SPRING LOAD PER SIDE
BUNGEE SPRING ATTACH POINT
.060 DIA.
.281 DIA. 4 HOLES
.010 DIA.
CYLINDER ATTACH POINT
.060 DIA.
L3010024 FITTING
L3010047 FITTING ASSY.
.250
6500 LB ULT. CYL. LOAD (BOOTSTRAPPED)
11900 LB ULT CYL LOAD (BOOTSTRAPPED)
1.96
2.666
1.625
3.00
SHIM
.250 DIA. 3 HOLES TO MATCH L3400324 2 SIDES IN LINE
L3400311
L3400318
L3400321
1.06
L3400306 AFT. DRAG BRACE (L.O. L9340073)
2.00
NOTE:
SUGGESTED METHOD OF INSTALLATION
1. ASSEMBLE L3400324 & L3400326 BRKTS. TO SIDE PLATES.
2. JIG LOCATE DOWNLOCK BRACE ATTACH POINT IN LINE WITH NLG SHOCK STRUT TRUNION POINTS
3. SHIM SIDE PLATES TO OBTAIN ALIGNMENT
FRAME
L9340074
B
19
18
17
16
15
14

J



L3400321-001 LINK, LOWER
7075-T73 DIE FORGING
L3400204 ROD END
L3400365-001
CABLE ASSY.
L3400352
CENTER JOINT
IDENTICAL TO
L3400033
GROUND SAFETY PIN
VIEW A-A
L3400366 SUPPORT
NAS1304-30 BOLT
INSTALL PER FINISH 18DA
DRILL .193
DRILL .313
L3400320-001
7075-T73
L3400319
BRACE
15,000
L5800478 BARREL
L5800479 CYL. ASSY.
NAS43DD3-437 SPACER (AL)
L3400204 ROD END
L3400322 SUPPORT
MAT'L 6061-T6
QQ-A-250/11-T6
AN6-7A BOLT (CAD)
MS21042L4 NUT (CAD)
AN4-25A BOLT (CAD)
MS21042L4 NUT (CAD)
L3400321 LINK, LOWER
L3400320 LINK, UPPER
SECTION D-D
SECTION C-C
L3400318 PIN
L3400321 LINK
MS24665-283 COTTER
LD131-0019-0008 BEARING
LD137-0007-0006 BUSHING
L3400322 PIN
MS20002-6 WASHER
AN320-6 NUT
MS24665-283 COTTER
L5802999 HYD SWIVEL
NLG TRUNION AXIS
TO MATCH SIDES
BOLT 160 K.S.I.
BOLT 160 K.S.I.
L3400326 SUPPORT
LD L9340077
STRUT DOOR
L3010024 FITTING
L3010097 FITTING ASSY
7.600
3.125
3.000
2.375
2.000
1.000
2.00
2.83
2.12
2.16
3.20
3.85
L9340074
C
1
14
13
12
11
10
9

3



L5800475 ROD END
L3400370 PIN (CAD)
MS 20002-C8 WASHER (CAD)
AN 320-8 NUT (CAD)
MS 24665-265 COTTER (CAD)
SECTION E-E
L3400365-001 CABLE ASSY.
L3400352 TERMINAL
14.8 MAX. SPRING LENGTH
235 LB. LOAD
66±.12 LENGTH OF CABLE ASSY
DRILL .193
DRILL .313
L3400320-001 LINK, UPPER 7075-T73. DIE FORGING
L3400319 DOWNLOCK BRACE ASSY.
15,000 LB. ULT
13.75 INSTALLED LGTH
L3400041 SPRING
L3400040 PULLEY
17.00 MAX CYL. LGTH. REQD
17.30 AVAILABLE
12.25 MIN. CYL. LGTH REQD.
12.20 AVAILABLE
4.75 STROKE REQ'D.
5.10 STROKE AVAILABLE
.25 OVERSTROKE
L5800479 CYLINDER ASSY.
.281 DIA. 4 HOLES
.010 DIA.
SECTION B-B
NOMINAL UP POSITION OF LOWER LINK
OVER TRAVEL
11,900 LB ULT COMP.
8300 LB. ULT. TENS.

Figure 11

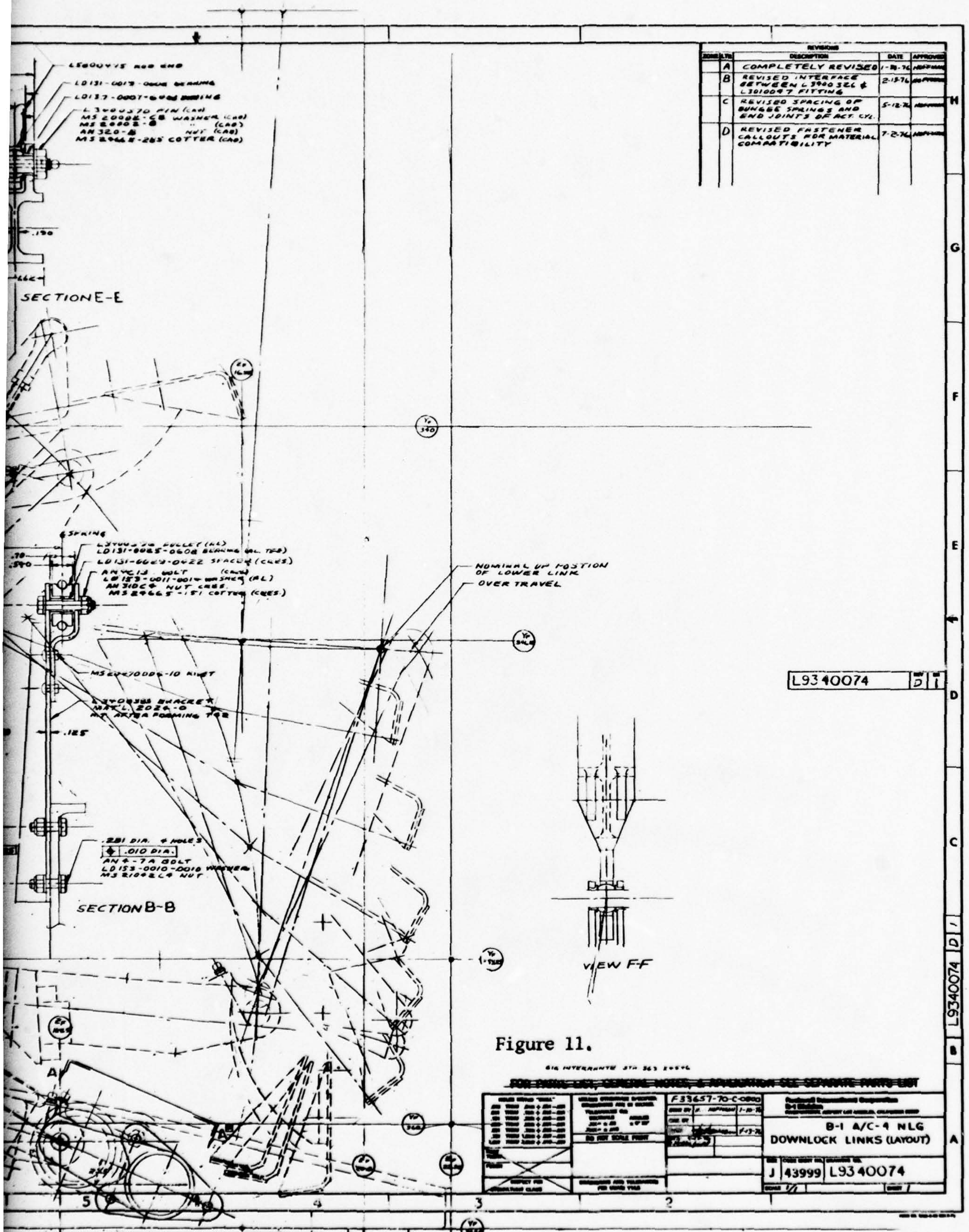


Figure 11.

5

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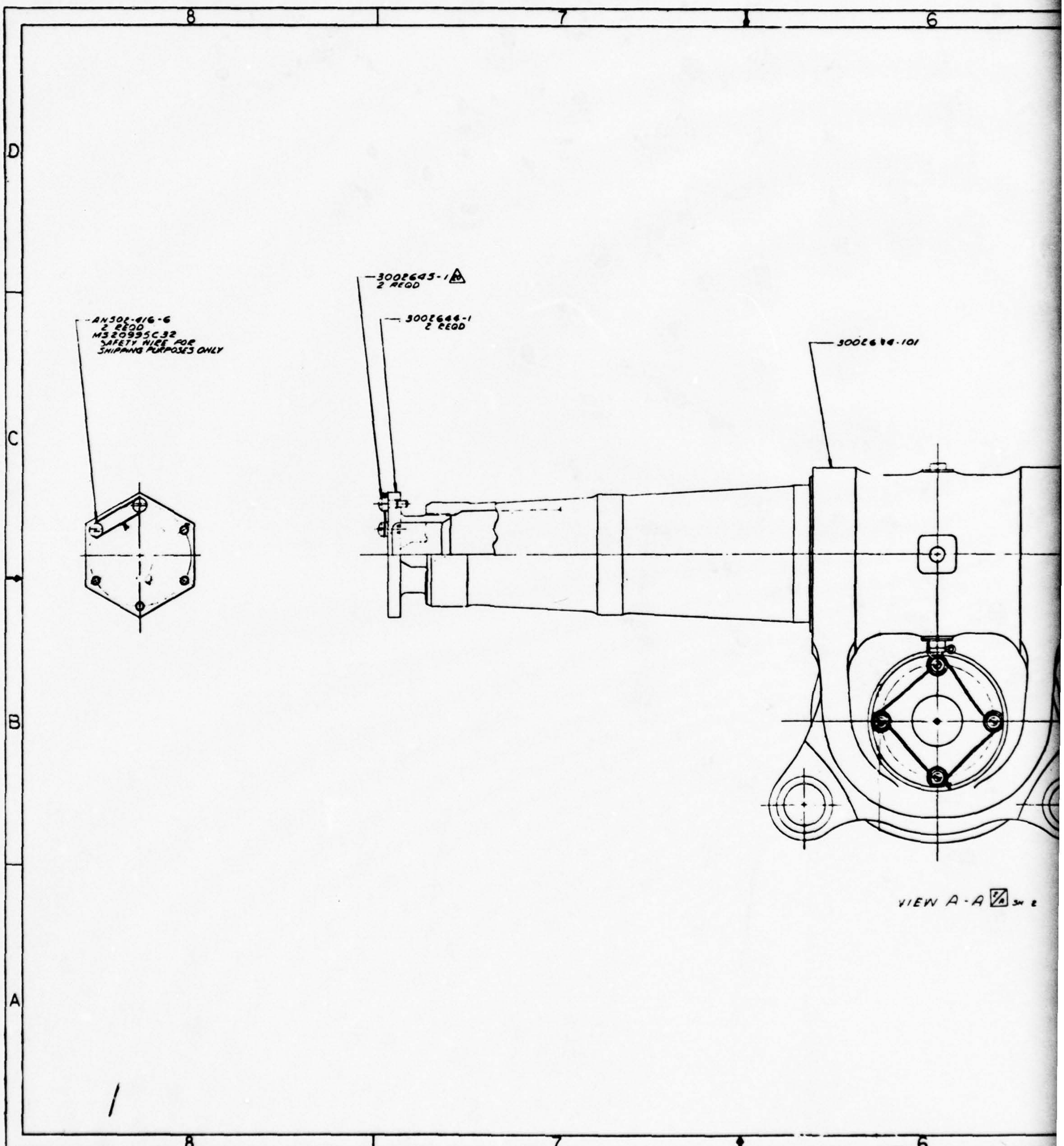
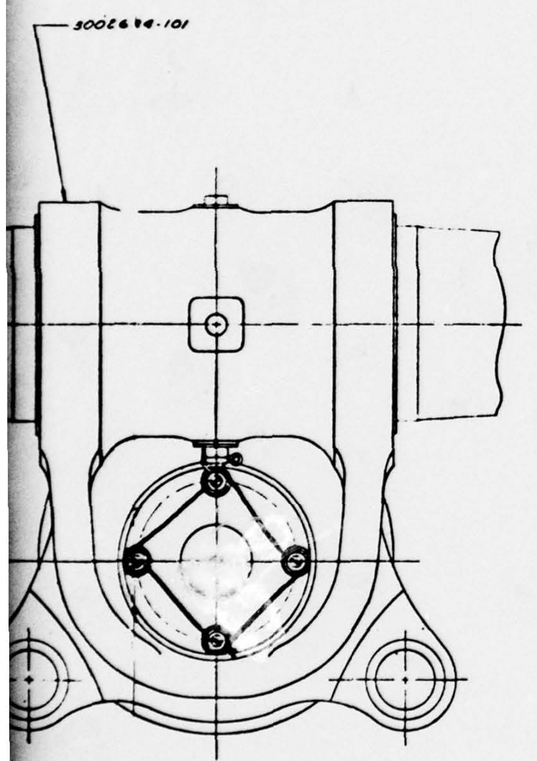

8
7
6
D
C
B
A
AN502-416-6
2 REQD
MS20995C32
SAFETY WIRE FOR
SHIPPING PURPOSES ONLY
3002645-1
2 REQD
3002644-1
2 REQD
3002674-101
VIEW A-A
SH 2
1

6 | 5 | 4



VIEW A-A 7/A SH 2

34 INSTALL WITH BLACK BACK-UP RINGS ON OUTSIDE OF PACKING ASSY

33 WITH TORQUE ARM APEX DISCONNECTED AND UPPER TORQUE ARM PERPENDICULAR TO CENTERLINE OF STRUT, TORQUE 3002639-1 OR 3002682-1 NUT UNTIL A FORCE ALONG CENTERLINE OF TORQUE ARM APEX OF 50-70 FT/LBS IS REQUIRED TO START STEER COLLAR ROTATING. BACK-OFF TO NEAREST LOCKING SLOT

32 DO NOT COAT THREADS WITH THREAD COMPOUND PER MIL-T-5544

31 POSITION ZERO MARK 180° ± ½° FROM TORQUE ARM LUGS CENTERLINE

30 AFTER PLATING, APPLY SEALANT BEAD AROUND ALL BUSHING FLANGE OD'S PER MM5743

29 TORQUE TO BOTTOM OUT 3002629-1 RETAINER AND BACK-OFF TO THE NEAREST LOCKING HOLE

28 ADJUST 3002681-1 NUT (MINIMUM OF 100 FT/LBS TORQUE) BACK OFF TO PROVIDE A GAP OF .004-.007, LOCK NUT. PERFORM THIS OPERATION BEFORE 33

27 TORQUE TO BOTTOM OUT 3002623-1 GLAND NUT AND BACK-OFF TO THE NEAREST LOCKING SLOT

26 INSTALL PER MM4955, TYPE IA AFTER 18

25 DO NOT PAINT THESE SURFACES

24 TORQUE TO PROVIDE A MAXIMUM CLEARANCE OF .001 BETWEEN TORQUE ARM INNER BUSHING FACES AND ATTACHING PART BUSHING FACES TORQUE ARM TO ROTATE FREELY AFTER ASSEMBLY

23 POSITION IN APPROXIMATE CENTER OF ADJUSTMENT RANGE. BEND MS24665-372 COTTER PIN ONLY ENOUGH TO RETAIN FOR SHIPPING

22 SEAT 3002608-101 DIAPHRAGM ASSY AND DIMPLE 3002643-1 LOCK INTO SLOT ON 3002605-1 TUBE

21 WITH STRUT FULLY COMPRESSED ADJUST 3002666-1 INDICATOR PLATE TO ALIGN WITH INDEXING NOTCH ON UPPER TORQUE ARM

20 DO NOT COAT WITH PRIMER

19 INSTALL ALL BOLTS AND PINS WITH OD AND CONTACTING SURFACES COATED WITH WET EPOXY POLYAMIDE PRIMER PER MIL-P-23377, EXCEPT 20

18 TORQUE TO REMOVE ALL PERCEPTABLE END PLAY AND BACK OFF TO THE NEAREST HOLE

17 DELETED

16 COAT ALL THREADS WITH THREAD COMPOUND PER MIL-T-5544 EXCEPT AS NOTED

15 LUBRICATE WITH MIL-G-81322 GREASE

14 IMMERSE PACKINGS SEALS, BACKUP RINGS & WIPER RINGS IN MZ-V AND LIGHTLY COAT WITH VV-P-236 PETROLATUM BEFORE INSTALLING

13 BEFORE INSTALLATION- STAMP SERIAL NUMBER, PART DASH NO AND CHANGE LETTER. FILL STAMPED CHARACTERS WITH BLACK LACQUER COLOR NO. 17038 PER FED-STD-595

12 SAFETY WIRE PER MS33540

11 STENCIL .5 INCH HIGH LETTERS WITH BLACK EPOXY ENAMEL PER MIL-P-22808 COLOR NO. 17038 PER FED-STD-595

10 APPLY ONE COAT EPOXY POLYAMIDE PRIMER PER MIL-P-23377 AND ONE COAT URETHANE COATING PER MIL-C-83286, GLOSS INSIGNIA WHITE, COLOR NO. 17875 PER FED-STD-595 MASK ALL FUNCTIONAL SURFACES BEFORE PAINTING

9 ACCEPTANCE TEST PER MM3925

8 APPROXIMATE STRUT CAPACITY 22.5 QUARTS. FILL WITH CHEVRON MZ-V HYDRAULIC FLUID CHARGE WITH DRY NITROGEN CONFORMING TO MIL-P-27401

7 SPARE SEALS ARE NOT ESSENTIAL FOR GEAR OPERATION

6 MENASCO STRESS ANALYSIS REPORT CSR 007

5 DESIGNED IN ACCORDANCE WITH NORTH AMERICAN ROCKWELL SPECIFICATION L287C2002

4 FULLY EXTENDED AIR PRESSURE:
130 PSIG (PRIMARY CHAMBER)
1,060 PSIG (SECONDARY CHAMBER)

3 COMPRESSION RATIO 3.47 TO 1 (ABSOLUTE) STATIC TO FULLY COMPRESSED

2 WEIGHT (WET) 667.9 LBS MAXIMUM

1 THIS IS AN INTERCHANGEABLE ASSEMBLY PER MIL-I-8500

NOTES:

3002600 | SH 1

6 | 5 | 4

V

4	3	2

INSTALL WITH BLACK BACK-UP RINGS ON OUTSIDE OF PACKING ASSY

WITH TORQUE ARM APEX DISCONNECTED AND UPPER TORQUE ARM PERPENDICULAR TO CENTERLINE OF STRUT, TORQUE 3002639-1 OR 3002682-1 NUT UNTIL A FORCE ALONG CENTERLINE OF TORQUE ARM APEX OF 50-70 FT/LBS IS REQUIRED TO START STEER COLLAR ROTATING. BACK-OFF TO NEAREST LOCKING SLOT

DO NOT COAT THREADS WITH THREAD COMPOUND PER MIL-T-5544

POSITION ZERO MARK 180° ± ½° FROM TORQUE ARM LUGS CENTERLINE

30 AFTER PLATING, APPLY SEALANT BEAD AROUND ALL BUSHING FLANGE ODS PER MM5743

TORQUE TO BOTTOM OUT 3002629-1 RETAINER AND BACK-OFF TO THE NEAREST LOCKING HOLE

MAXIMUM 3002681-1 NUT (MINIMUM OF 100 FT/LBS TORQUE) BACK OFF TO PROVIDE A GAP OF .004-.007, LOCK NUT. PERFORM THIS OPERATION BEFORE 25

TORQUE TO BOTTOM OUT 3002623-1 GLAND NUT AND BACK-OFF TO THE NEAREST LOCKING SLOT

INSTALL PER MM4955, TYPE IA AFTER 10

DO NOT PAINT THESE SURFACES

TORQUE TO PROVIDE A MAXIMUM CLEARANCE OF .001 BETWEEN TORQUE ARM INNER BUSHING FACES AND ATTACHING PART BUSHING FACES. TORQUE ARM TO ROTATE FREELY AFTER ASSEMBLY

POSITION IN APPROXIMATE CENTER OF ADJUSTMENT RANGE. BEND MS24665-372 COTTER PIN ONLY ENOUGH TO RETAIN FOR SHIPPING

SEAT 3002608-101 DIAPHRAGM ASSY AND DIMPLE 3002643-1 LOCK INTO SLOT ON 3002605-1 TUBE

WITH STRUT FULLY COMPRESSED ADJUST 3002666-1 INDICATOR PLATE TO ALIGN WITH INDEXING NOTCH ON UPPER TORQUE ARM

DO NOT COAT WITH PRIMER

INSTALL ALL BOLTS AND PINS WITH OD AND CONTACTING SURFACES COATED WITH WET EPOXY POLYAMIDE PRIMER PER MIL-P-23377, EXCEPT 20

TORQUE TO REMOVE ALL PERCEPTABLE END PLAY AND BACK OFF TO THE NEAREST HOLE

DELETED

16 COAT ALL THREADS WITH THREAD COMPOUND PER MIL-T-5544 EXCEPT AS NOTED

15 LUBRICATE WITH MIL-G-81322 GREASE

14 IMMERSE PACKINGS SEALS, BACKUP RINGS & WIPER RINGS IN MLH-V ... LIGHTLY COAT WITH VV-P-236 PETROLATUM BEFORE INSTALLING

BEFORE INSTALLATION - STAMP SERIAL NUMBER, PART DASH NO AND CHANGE LETTER. FILL STAMPED CHARACTERS WITH BLACK LACQUER COLOR NO. 17038 PER FED-STD-595

SAFETY WIRE PER MS33540

STENCIL .5 INCH HIGH LETTERS WITH BLACK EPOXY ENAMEL PER MIL-P-22808 COLOR NO. 17038 PER FED-STD-595

APPLY ONE COAT EPOXY POLYAMIDE PRIMER PER MIL-P-23377 AND ONE COAT URETHANE COATING PER MIL-C-83286, GLOSS INSIGNIA WHITE COLOR NO 17875 PER FED-STD-595. MASK ALL FUNCTIONAL SURFACES BEFORE PAINTING

9 ACCEPTANCE TEST PER MM3925

8 APPROXIMATE STRUT CAPACITY 22.5 QUARTS. FILL WITH CHEVRON MIL-V HYDRAULIC FLUID CHARGE WITH DRY NITROGEN CONFORMING TO MIL-P-27401

7 SPARE SEALS ARE NOT ESSENTIAL FOR GEAR OPERATION

6 MENASCO STRESS ANALYSIS REPORT CSR 007

5 DESIGNED IN ACCORDANCE WITH NORTH AMERICAN ROCKWELL SPECIFICATION L287C2002

4 FULLY EXTENDED AIR PRESSURE:
130 PSIG (PRIMARY CHAMBER)
1,060 PSIG (SECONDARY CHAMBER)

3 COMPRESSION RATIO 3.47 TO 1 (ABSOLUTE) STATIC TO FULLY COMPRESSED

2 WEIGHT (WET): 667.9 LBS MAXIMUM

1 THIS IS AN INTERCHANGEABLE ASSEMBLY PER MIL-I-8500

NOTES:

-503	-501	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	ZONE	SH	MATERIAL	MATERIAL SPECIFICATION	UNIT WEIGHT	FINISH
2	-	AN9116A	BOLT	9C	2				
2	2	NAS517-3-4	SCREW	2A	2				
2	2	MS20365-1032	NUT	2A	2				
2	2	LE1046663-0001	AIRVALVE	8C 12C	2				
1	1	RZA12079	INSERT	8C	2	ROSAN INC			
1	1	RZA11032	LOCKRING	8C	2	ROSAN INC			
1	-	3002680-3	FLOATING PISTON	AC	2				
2	2	18230204	GAGE, PRESSURE	12 10	2	ADVANCED TECHNOLOGY DIV, MTE INDUSTRIES			
2	2	7461FT-253-4100	PACKING ASSY	4C	2	GREEN TWEED & CO			
2	2	M4307-253-N	PACKING ASSY	4C	2				
1	1	M4HITE-253-4100	PACKING ASSY	8C	2				
1	1	7C6476-253-T	PACKING ASSY	9C	2	GREEN TWEED & CO			
2	2	AN177C16	BOLT	7C	2				
	1	MS28932C-2206	WIPER	9C	2				
2	2	MS28777-4	RING BACK UP	5A 7D	2				
1	1	MS28776-M257	SCRAPER	3B	2				
2	2	MS28774-210	RETAINER	5C	2				
2	2	MS28774-436	RETAINER	5C	2				
2	2	MS28774-438	RETAINER	9C	2				
2	2	MS24665-372	PIN, COTTER	2B 8D	2				
2	2	MS24665-300	PIN, COTTER	7D	2				
2	2	MS28782-65	RETAINER	8C	2				
	1	MS24665-132	PIN, COTTER	5C	2				
2	2	MS17820-7	NUT	7D	2				
2	2	MS21045-4	NUT	11B	2				
AR	AR	MS20995C32	LOCKWIRE	FD	1-2				
1	1	MS20392-8C37	CLEVIS PIN	9C	2				
4	4	MS20005H12	BOLT	2A	2				
1	1	MS20002-22	WASHER	9C	2				
17	17	MS15001-1	FITTING, LUB	FD	2				
1	1	AN960-1016	WASHER	6D	2				
2	2	AN960-716L	WASHER	7D	2				
6	6	AN960-516L	WASHER	12D	2				
2	2	AN960-416	WASHER	11B	2				
2	2	AN960-10L	WASHER	2A	2				
2	2	AN960-516	WASHER	12D	2				
4	4	AN502-416-6	SCREW	5C 8C	2 1				
2	2	AN960-C...	WASHER	5A	2				
1	1	AN310-10	NUT	6D	2				
2	2	MS21045-5	NUT	12D	2				
2	2	AN5-23A	BOLT	12D	2				
2	2	AN4-10A	BOLT	11B	2				
1	1	3002669-1	PLATE, SERVICING	6A	2				
	1	3002659-3	PACKING	8C	2				
2	2	3002659-1	PACKING	3A 3D	2				
1	1	3002636-1	NUT, HEX T/A APEX	2D	2				
1	1	3002624-3	RING, RETAINING	9C	2				
-	1	3002680-1	FLOATING PISTON	8C	2				
1	1	3002678-1	WASHER, T/A APEX	2D	2				
1	1	3002675-1	BOLT, UPSTOP	7C	2				
1	1	3002674-101	ROLLER ASSY, UPSTOP	7D	2				
4	4	3002672-1	WASHER, SERR	7C	2				
	1	3002671-102	UPSTOP, RH	7D	2				
	1	3002671-101	UPSTOP, LH	7C	2				
1	1	3002667-1	SLEEVE, UPSTOP	7D	2				
	1	3002666-1	PLATE, INDICATION	3D	2				
	1	3002665-1	PLATE, ANGLE INDICATION	4A	2				
3	3	3002664-5	SHIM	12C	2				
2	2	3002664-3	SHIM	12C	2				
1	1	3002664-1	SHIM	12C	2				
2	2	3002663-1	WASHER, SERR	11C	2				
2	2	3002662-1	NUT, TRUNNION	11C	2				
2	2	3002661-1	PIN, TRUNNION	11C	2				
1	1	3002660-1	PLATE, IDENT	6A	2				

QTY REQD

LIST OF MATERIALS

-503	-501	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION
1	-	3002604-103	COLLAR ASS...
1	-	3002652-3	SUPPORTING...
-	1	3002647-1	WASHER, BELL...
-	1	3002685-1	NUT, STEER...
1	-	3002685-1	COLLAR, METE...
1	-	3002684-1	LOCK
1	-	3002682-1	NUT
	1	3002659-13	PACKING
	1	3002659-11	PACKING
2	2	3002659-9	PACKING
1	1	3002659-7	PACKING
1	1	3002659-5	PACKING
2	2	3002658-101	RETAINER A...
2	2	3002657-1	SPACER, S...
1	1	3002656-1	SPACER, S...
2	2	3002655-1	BOLT, T/A ...
1	1	3002654-101	BOLT ASSY ...
1	-	3002683-1	WASHER, B...
2	2	3002646-1	SPACER
2	2	3002645-1	SCREW
2	2	3002644-1	AXLE NU...
1	1	3002643-1	LOCK, DIA...
1	1	3002642-1	RING, ORIFIC...
2	2	3002640-1	KEY, STEER...
1	1	3002639-1	BUSHING, KE...
1	1	3002638-1	BUSHING, ...
1	-	3002681-1	NUT, STEER...
1	1	3002634-101	PISTON ...
1	1	3002633-1	JAR & PA...
-	1	3002632-1	SUP. UNIT ...
	1	3002630-1	NUT, FILLE...
1	1	3002629-1	COVER, CY...
1	1	3002628-1	RETAINER, ...
-	1	3002627-1	COLLAR, ...
1	1	3002626-1	EXTENSION, ...
1	1	3002625-1	PIN, METE...
	1	3002624-1	RING, RET...
1	1	3002623-1	NUT, GLA...
1	1	3002622-1	ADAPTER, ...
1	1	3002621-1	ADAPTER, ...
1	1	3002620-1	BEARING, ...
2	2	3002619-1	LOCK, NU...
1	1	3002617-101	CAM ASSY, ...
2	2	3002616-1	KEY, UPP...
1	1	3002615-3	RING, RET...
2	2	3002615-1	RING, RETA...
1	1	3002614-1	RING, SHU...
	1	3002613-1	CAM, UPPE...
	1	3002612-1	RETAINER, ...
	1	3002611-1	BEARING, ...
	1	3002609-1	DIAPHRAGM, ...
	1	3002608-101	DIAPHRAGM ...
2	2	3002607-1	NUT, JAM
1	1	3002605-1	TUBE, ORI...
-	1	3002604-101	COLLAR AS...
2	2	3002603-101	TORQUE ARM ...
1	1	3002601-101	CYLINDER ...
		-503	SHOCK STR...
		-501	SHOCK STR...

QTY REQD

Figure 12.

2	C	AIRPLANE	B-1
1	C	AIRPLANE	B-1
SH	REV	NEXT ASSEMBLY	USED ON
REV STATUS		APPLICATION	

4	3	2

3

ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	SEE ECD NO 53718	4-7-72	
	B	SEE ECD NO 54381	5-8-73	
	C	SEE ECD NO 54793	8-8-73	

NOMENCLATURE OR DESCRIPTION	ZONE	SH	MATERIAL
	9C	2	
	2A	2	
	2A	2	
	8C	2	
	8C	2	ROSAN INC
	8C	2	ROSAN INC
PISTON	8C	2	
SSURE	12 10	2	ADVANCED TECHNOLOGY DIV, ATL INDUSTRIES
ASSY	4C	2	GREEN TWEED & CO
ASSY	4C	2	
ASSY	8C	2	
ASSY	9C	2	GREEN TWEED & CO
	7C	2	
	3C	2	
UP	12 10	2	
	3B	2	
	3C	2	
	3C	2	
	9C	2	
TER	12 10	2	
TER	7D	2	
	8-	2	
TER	5C	2	
	7D	2	
	11D	2	
RE	FD	1-2	
PIN	5C	2	
	2A	2	
	9C	2	
LUB	FD	2	
	6D	2	
	7D	2	
	12D	2	
	11D	2	
	2A	2	
	4D	2	
	8C	1	
	2A	2	
	6D	2	
	12D	2	
	12D	2	
	11B	2	
CING	6A	2	
	8C	2	
	3A	2	
APEX	2D	2	
AINING	9C	2	
PISTON	8C	2	
APEX	2D	2	
STOP	7C	2	
SY UPSTOP	7D	2	
GEAR	7C	2	
RN	7D	2	
AN	7C	2	
UPSTOP	7D	2	
ICATION	1D	2	
ICATION	6A	2	
	12C	2	
	12C	2	
	12C	2	
GEAR	11C	2	
NION	11C	2	
NNION	11C	2	
DENT	6A	2	

LIST OF MATERIALS

Figure 12.

2	C		B-1	
1	C		B-1	
SH	REV			
REV STATUS		APPLICATION		

-502	-501	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	ZONE	SH
1	-	3002604-03	COLLAR ASSY	4C	2
1	-	3002652-3	SUPPORTING RING	9C	2
-	1	3002647-1	WASHER BELLVILLE	3A	2
-	1	3002685-1	NUT, STEER COLLAR	9A	2
1	-	3002685-1	COLLAR, METER PIN	5C	2
1	-	3002684-1	LOCK	3C	2
1	-	3002682-1	NUT	3C	2
	1	3002659-13	PACKING	9C	2
	1	3002659-11	PACKING	9C	2
2	2	3002659-9	PACKING	8C	2
1	1	3002659-7	PACKING	5C	2
	1	3002659-5	PACKING	5C	2
2	2	3002658-101	RETAINER ASSY, T/A END	1B	2
2	2	3002657-1	SPACER, SERRATED	1B	2
1	1	3002656-1	SPACER, SERRATED	2C	2
2	2	3002655-1	BOLT, T/A END	2C	2
1	1	3002654-101	BOLT ASSY, T/A APEX	3D	2
1	-	3002653-1	WASHER, BELLVILLE	3C	2
2	2	3002616-1	SPACER	3B	2
2	2	3002645-1	SCREW	7D	1
2	2	3002644-1	AXLE NUT	7C	1
1	1	3002643-1	LOCK, DIAPHRAGM	6C	2
1	1	3002642-1	RING, ORIFICE SUPPORT	6C	2
2	2	3002640-1	KEY, STEER BUSHING	4C	2
1	1	3002639-1	BUSHING, KEYED, LWR	9C	2
1	1	3002638-1	BUSHING, KEYED	5C	2
1	-	3002601-1	NUT, STEER COLLAR	9C	2
1	1	[illegible]	[illegible] ASSY	6C	1
1	1	3002633-1	[illegible] PAD	2A	2
-	1	3002632-1	SUP[illegible] RING	9C	2
1	1	3002630-1	NUT, FILLER TUBE	10C	2
1	1	3002629-1	COVER, CYL	9C	2
1	1	3002628-1	RETAINER, FLOAT PISTON	8C	2
-	1	3002627-1	COLLAR, METER PIN	5C	2
1	1	3002626-1	EXTENSION, METER PIN	5C	2
1	1	3002625-1	PIN, METERING	5C	2
1	1	3002624-1	RING, RETAINING	9C	2
1	1	3002623-1	NUT, GLAND	3B	2
1	1	3002622-1	ADAPTER, WIPER	3B	2
1	1	3002621-1	ADAPTER, BRG LWR	4C	2
1	1	3002620-1	BEARING, LOWER	4C	2
2	2	3002619-1	LOCK, NUT	3C	2
1	1	3002617-101	CAM ASSY, LWR	5C	2
2	2	3002616-1	KEY, UPPER CAM	7C	2
1	1	3002615-3	RING, RETAINING	2B	2
2	2	3002615-1	RING, RETAINING	7C	2
1	1	3002614-1	RING, SNUBBER	7C	2
	1	3002613-1	CAM, UPPER	7C	2
	1	3002612-1	RETAINER, BRG UP	7C	2
	1	3002611-1	BEARING, UPPER	7C	2
1	1	3002609-1	DIAPHRAGM PISTON	3C	2
1	1	3002608-101	DIAPHRAGM ASSY	6C	2
2	2	3002607-1	NUT, JAM	12	2
1	1	3002605-1	TUBE, ORIFICE	6C	2
-	1	3002604-101	COLLAR ASSY	4C	2
2	2	3002603-101	TORQUE ARM ASSY	3D	2
1	1	3002601-101	CYLINDER ASSY	6C	2
		-502	SHOCK STRUT ASSY	6A	2
		-501	SHOCK STRUT ASSY	6A	2

LIST OF MATERIALS

MENASCO MFG COMPANY

BURBANK, CALIF

SHOCK STRUT ASSY, NOSE LANDING GEAR - S-1

39661 3002600

THESE DATA HAVE BEEN PLACED IN FILE PRIOR TO D/ 112:00 REVIEW

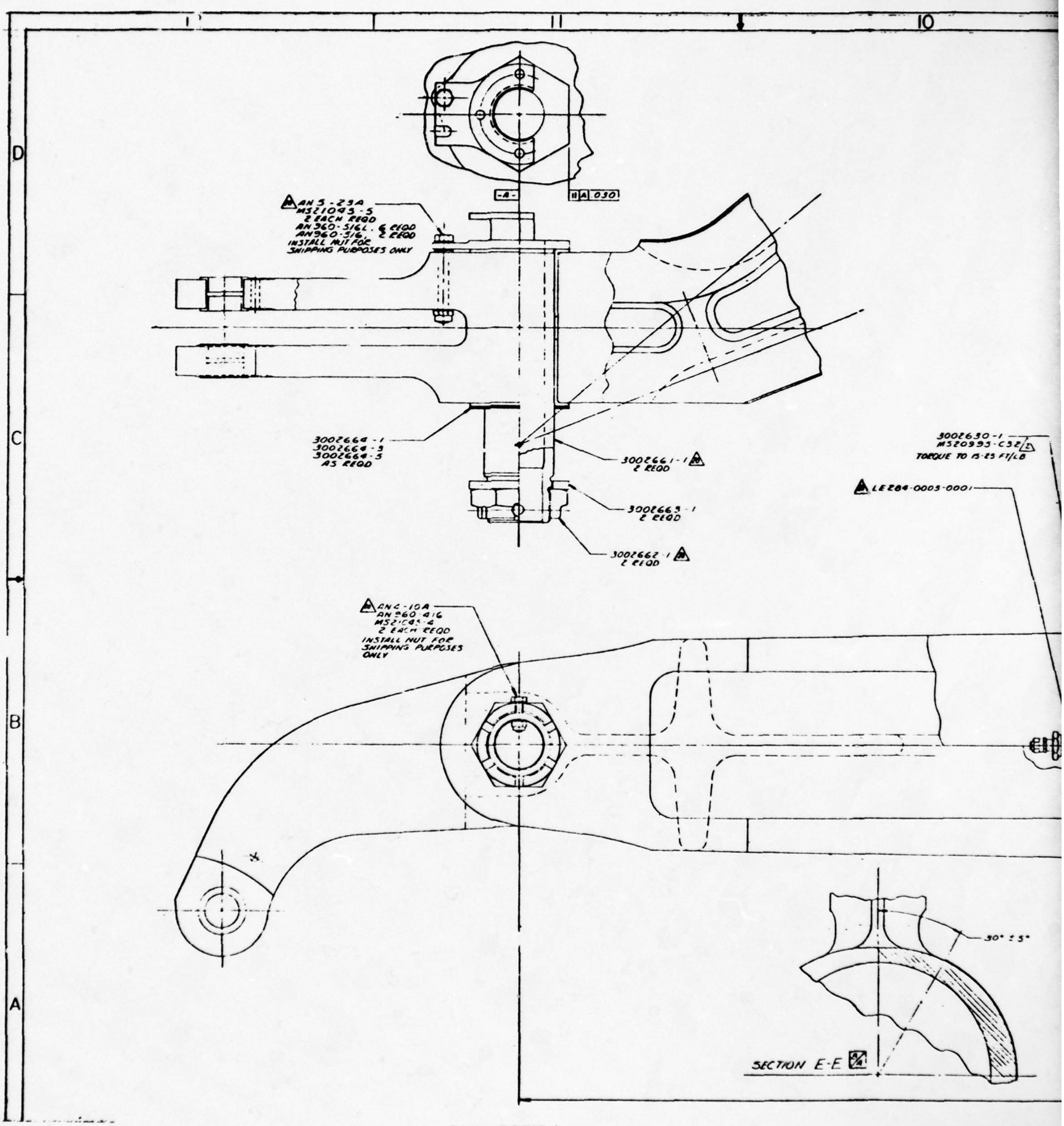
CONFIRM VALIDITY WITH OPR BEFORE USING.

MAY 13 1975

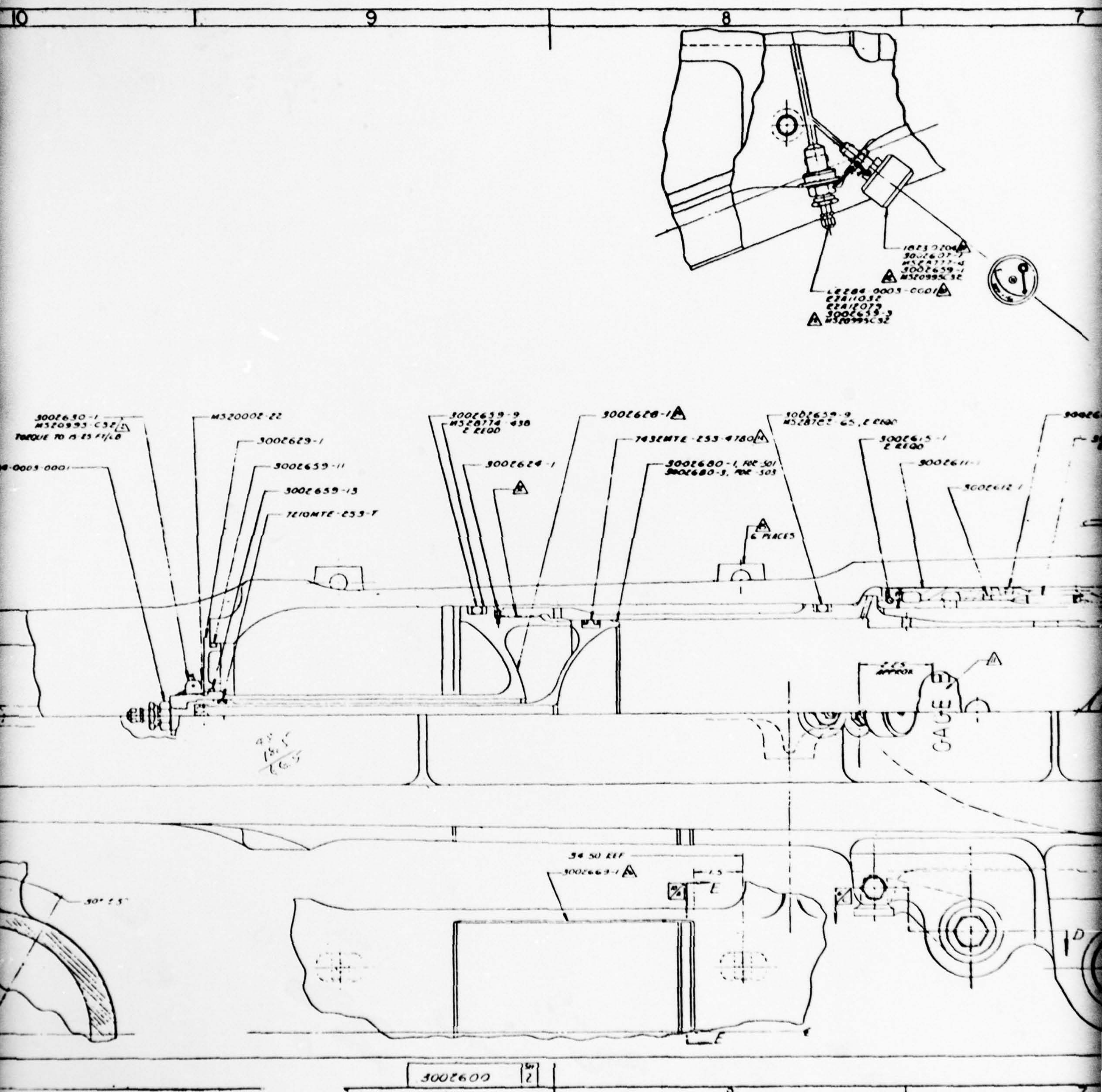
LDG & DECEL SYS

3002600

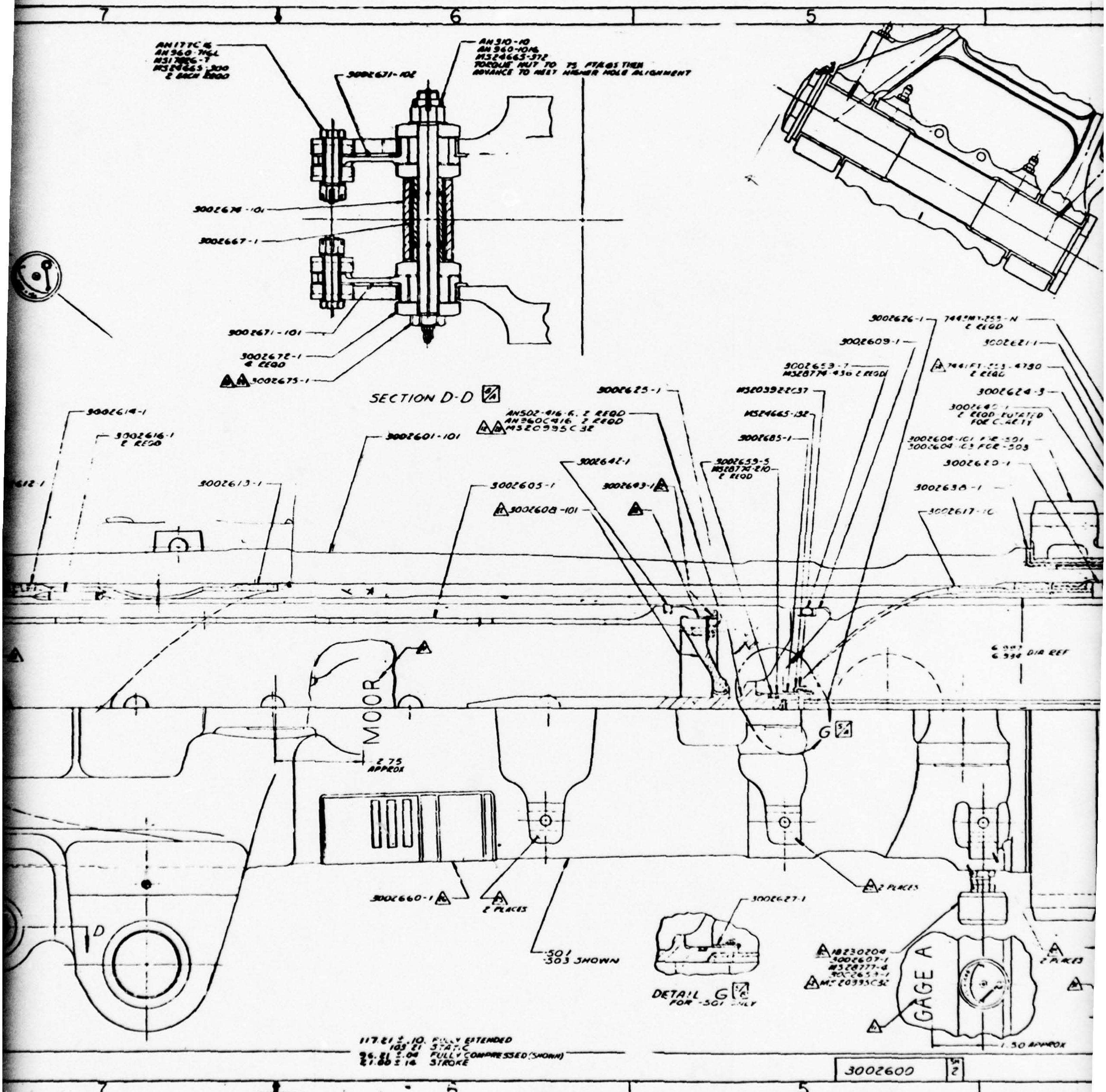
DELIVER PRINT TO



12
11
10
D
C
B
A
-A-
11 A .030
AN 5-23A
MS21043-5
2 EACH REQD
AN960-516L 6 REQD
AN960-516, 2 REQD
INSTALL NUT FOR
SHIPPING PURPOSES ONLY
3002664-1
3002664-3
3002664-5
AS REQD
3002661-1
2 REQD
3002663-1
2 REQD
3002662-1
2 REQD
3002630-1
MS20995-C32
TORQUE TO 15-25 FT/LB
LE284-0003-0001
AN4-10A
AN960-416
MS21045-4
2 EACH REQD
INSTALL NUT FOR
SHIPPING PURPOSES
ONLY
30° ± 5°
SECTION E-E

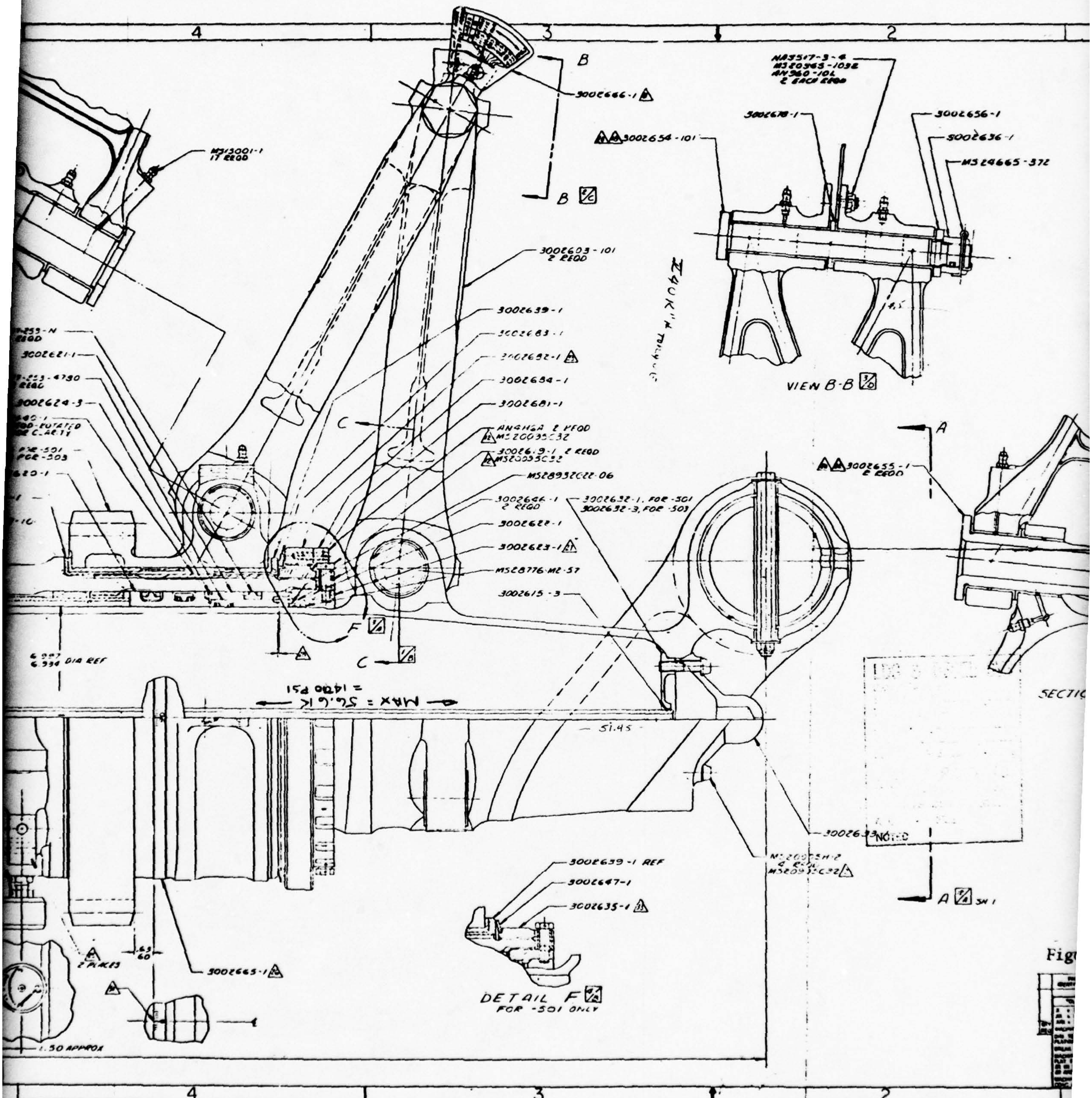

10
9
8
7
1823 0204
3002607-7
3002659-1
MS20995C32
3002659-3
MS20995C32
3002630-1
MS20995-C32
TORQUE TO 15-25 FT/LB
MS20002-22
3002629-1
3002659-11
3002659-13
3002659-9
3002624-1
3002628-1
3002680-1, FOR 501
3002680-3, FOR 503
3002659-9
3002615-1
3002611-1
3002612-1
6 PLACES
2.25
APPROX
GAUGE
34.50 REF
3002669-1
1.5
E
D
30° ± 5°
3002600
7

7



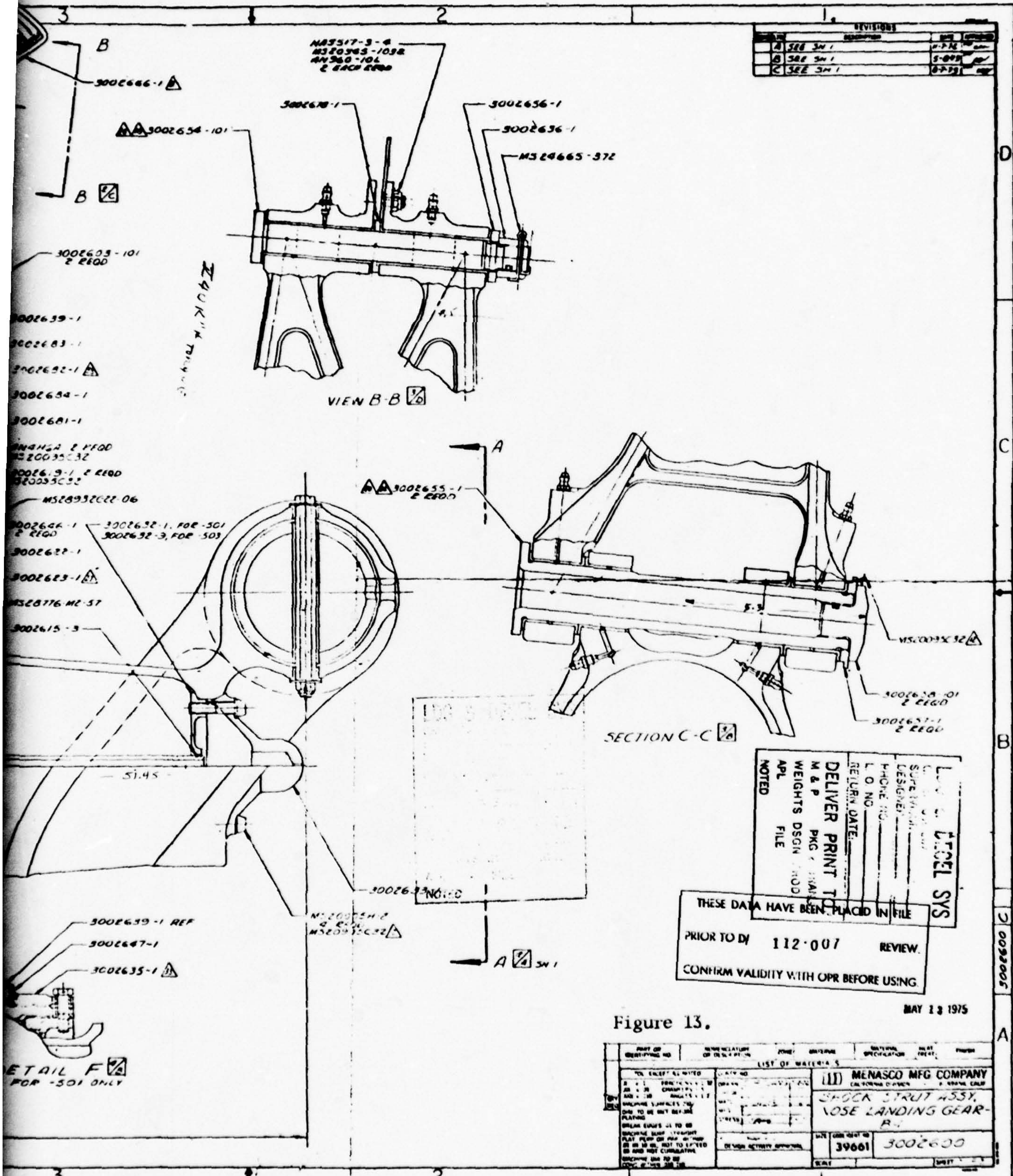
AN310-10
AN960-1016
MS24665-372
TORQUE NUT TO 75 FT-LBS THEN ADVANCE TO NEXT HIGHER HOLE ALIGNMENT
3002671-102
3002674-101
3002667-1
3002671-101
3002672-1
4 REQD
3002675-1
SECTION D-D
3002614-1
3002616-1
2 REQD
3002601-101
3002613-1
3002605-1
3002608-101
3002642-1
3002643-1
3002625-1
3002626-1
3002609-1
3002621-1
3002624-3
3002685-1
3002620-1
3002638-1
3002617-10
MS24665-132
3002604-101 FOR -501
3002604-103 FOR -503
6.997
6.994 DIA REF
MOOR
2.75
APPROX
3002660-1
2 PLACES
-501
-503 SHOWN
3002627-1
DETAIL G
FOR -501 ONLY
3002607-1
GAGE A
1.30 APPROX
117.21 ±.10 FULLY EXTENDED
103.21 STATIC
96.21 ±.04 FULLY COMPRESSED (SHOWN)
21.00 ±.14 STROKE
3002600

3



B
3002666-1
MS35517-3-4
MS20365-1032
AN960-10L
2 EACH REQD
3002678-1
3002656-1
3002636-1
MS24665-372
3002654-101
MS15001-1
17 REQD
3002603-101
2 REQD
3002639-1
3002683-1
3002632-1
3002684-1
3002681-1
3002621-1
3002624-3
VIEW B-B
3002655-1
2 REQD
A
MS28932022-06
3002646-1
2 REQD
3002632-1, FOR -501
3002632-3, FOR -503
3002622-1
3002623-1
MS28776-M2-57
3002615-3
C
F
51.45
MAX = 56.6K
= 1480 PSI
6.997
6.994 DIA REF
3002639-1 REF
3002647-1
3002635-1
3002665-1
2 PLACES
DETAIL F
FOR -501 ONLY
SECTION
4
3
2

4


REVISIONS
A SEE SH 1
B SEE SH 1
C SEE SH 1
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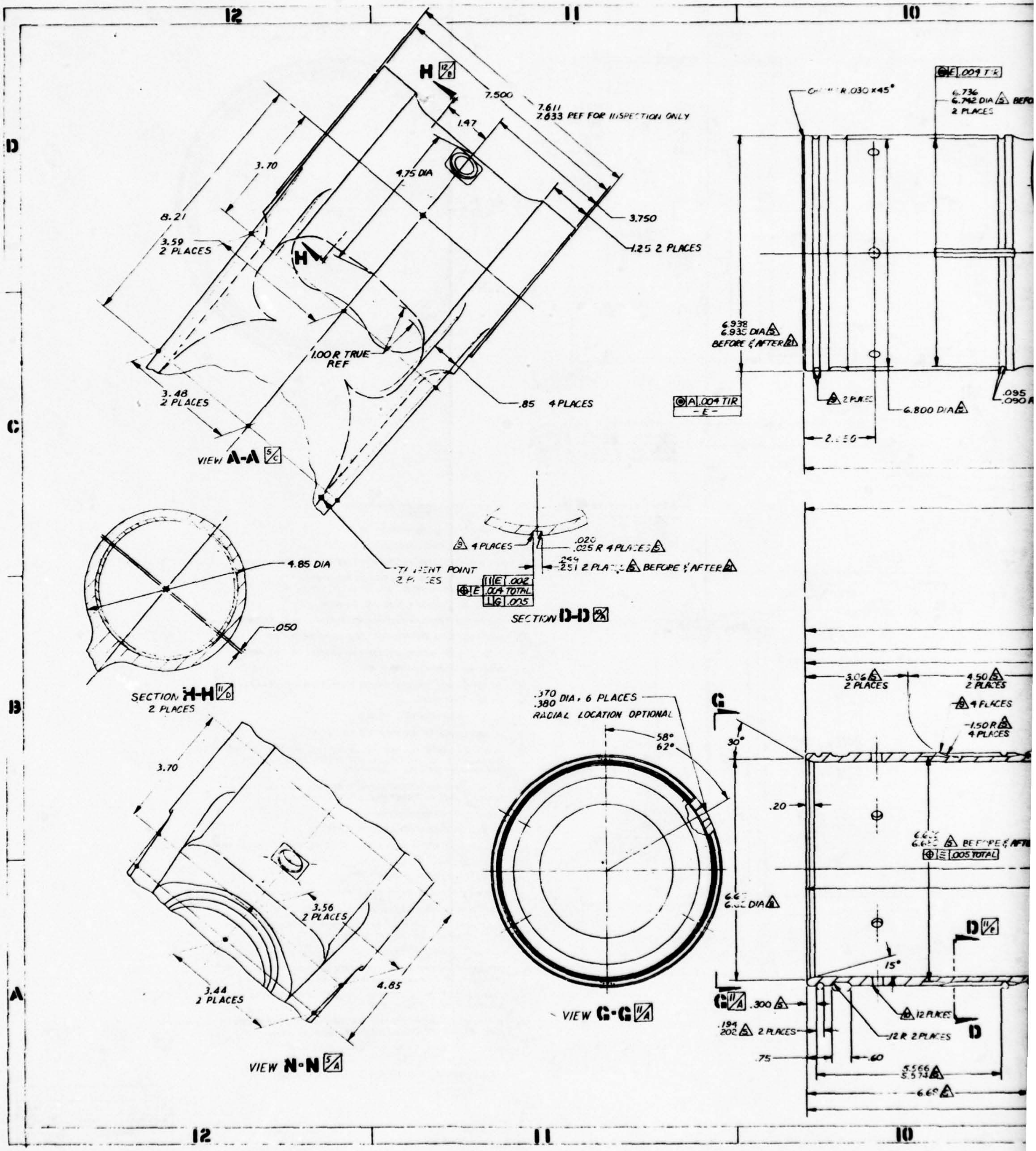
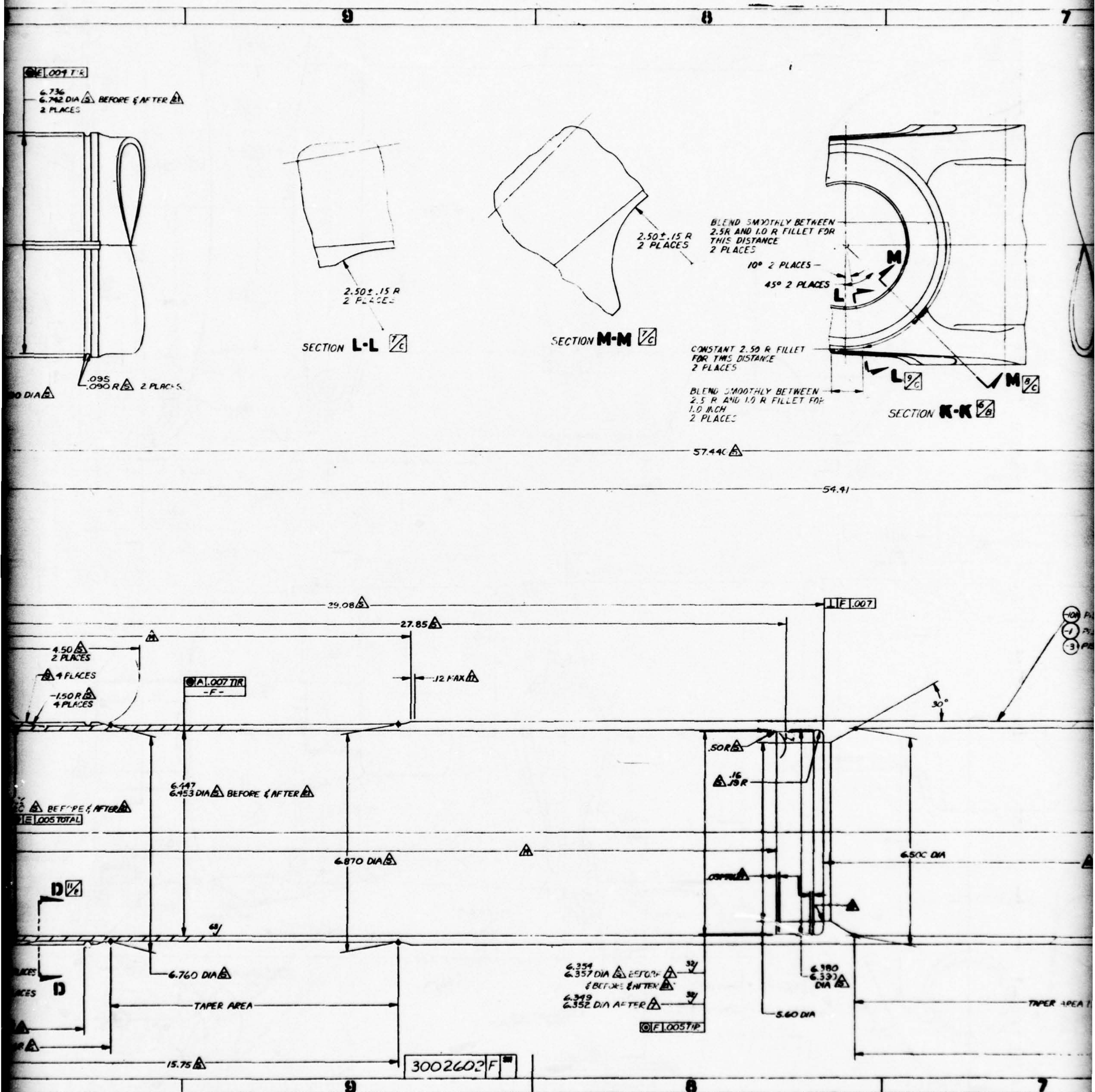
MS20365-1032
AN960-10L
2 EACH REQD
3002666-1
3002678-1
3002656-1
3002654-101
3002636-1
MS24665-372
3002603-101
2 REQD
3002639-1
3002683-1
3002632-1
3002684-1
3002681-1
VIEW B-B
3002655-1
2 REQD
MS28932022-06
3002632-1, FOR -501
3002632-3, FOR -503
3002627-1
3002623-1
MS28776-M2-57
3002615-3
MS20995C32
3002658-101
2 REQD
3002657-1
2 REQD
SECTION C-C
51.45
3002639-1 REF
3002647-1
3002635-1
DETAIL F
FOR -501 ONLY
DELIVER PRINT TO
RETURN DATE
L O NO
PHONE NO
DESIGNER
M & P
WEIGHTS DSGN
APL
FILE
NOTED
THESE DATA HAVE BEEN PLACED IN FILE
PRIOR TO D/ 112-007 REVIEW.
CONFIRM VALIDITY WITH OPR BEFORE USING
MAY 13 1975
LIST OF MATERIALS
MENASCO MFG COMPANY
SHOCK STRUT ASSY, NOSE LANDING GEAR-B-1
39661
3002600

Figure 13.

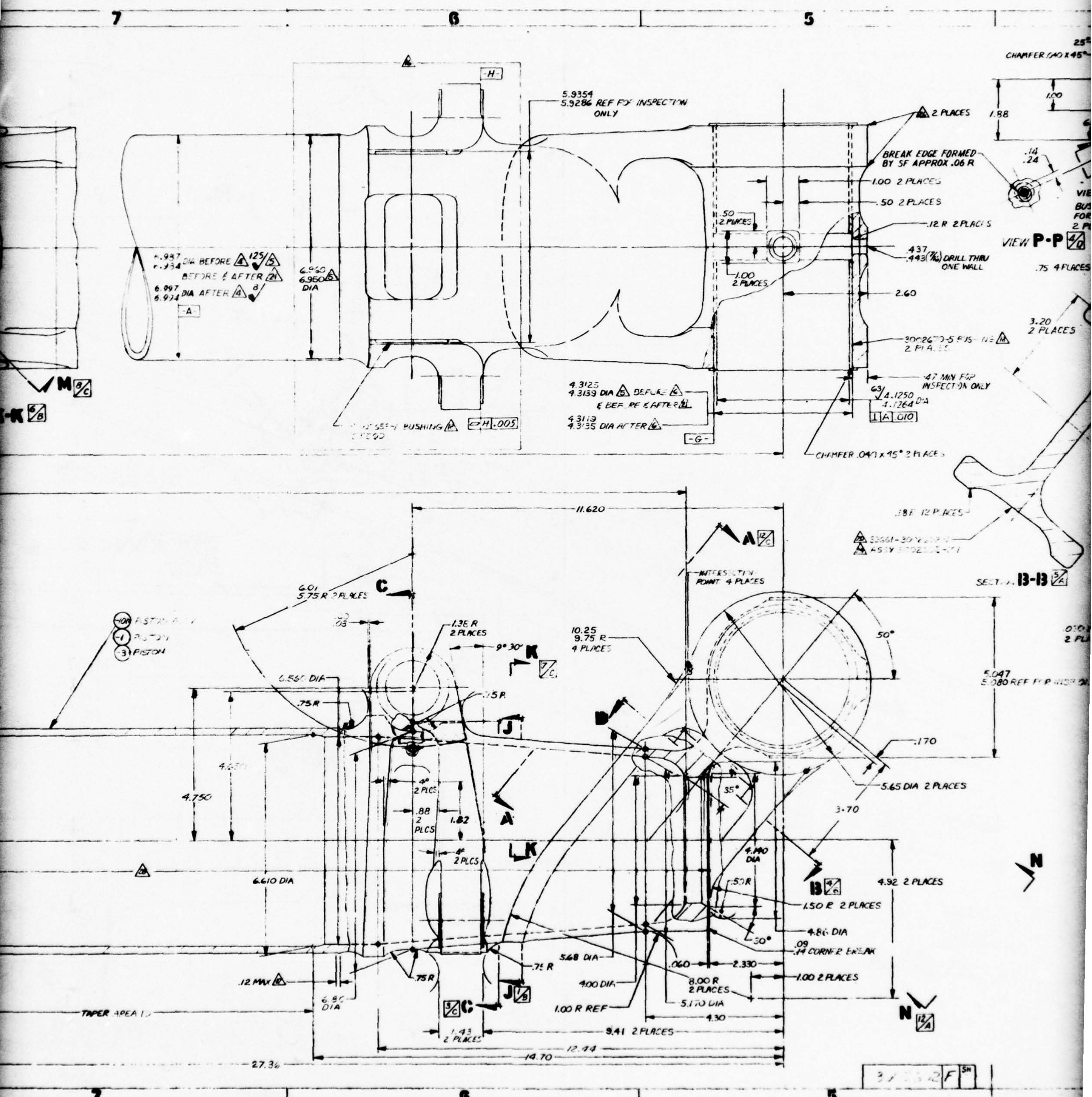
5



12
11
10
D
C
B
A
VIEW A-A 5/C
7.500
7.611
7.633 REF FOR INSPECTION ONLY
1.47
4.75 DIA
3.70
8.21
3.59
2 PLACES
3.750
1.25 2 PLACES
1.00 R TRUE
REF
3.48
2 PLACES
.85 4 PLACES
TANGENT POINT
2 PLACES
4.85 DIA
.050
SECTION H-H 11/D
2 PLACES
4 PLACES
.020
.025 R 4 PLACES
.251 2 PLACES BEFORE & AFTER
.002
.004 TOTAL
.005
SECTION D-D
.370
.380 DIA, 6 PLACES
RADIAL LOCATION OPTIONAL
58°
62°
30°
VIEW G-G 11/A
3.70
3.56
2 PLACES
3.44
2 PLACES
4.85
VIEW N-N 5/A
CHAMFER .030 x 45°
.009 TIR
6.736
6.742 DIA
2 PLACES
6.938
6.935 DIA
BEFORE & AFTER
.004 TIR
-E-
2 PLACES
6.800 DIA
.095
3.06
2 PLACES
4.50
2 PLACES
4 PLACES
1.50 R
4 PLACES
.20
BEFORE & AFTER
.005 TOTAL
DIA
15°
.300
12 PLACES
.194
.202
2 PLACES
.12 R 2 PLACES
.75
.60
5.566
5.573
6.69

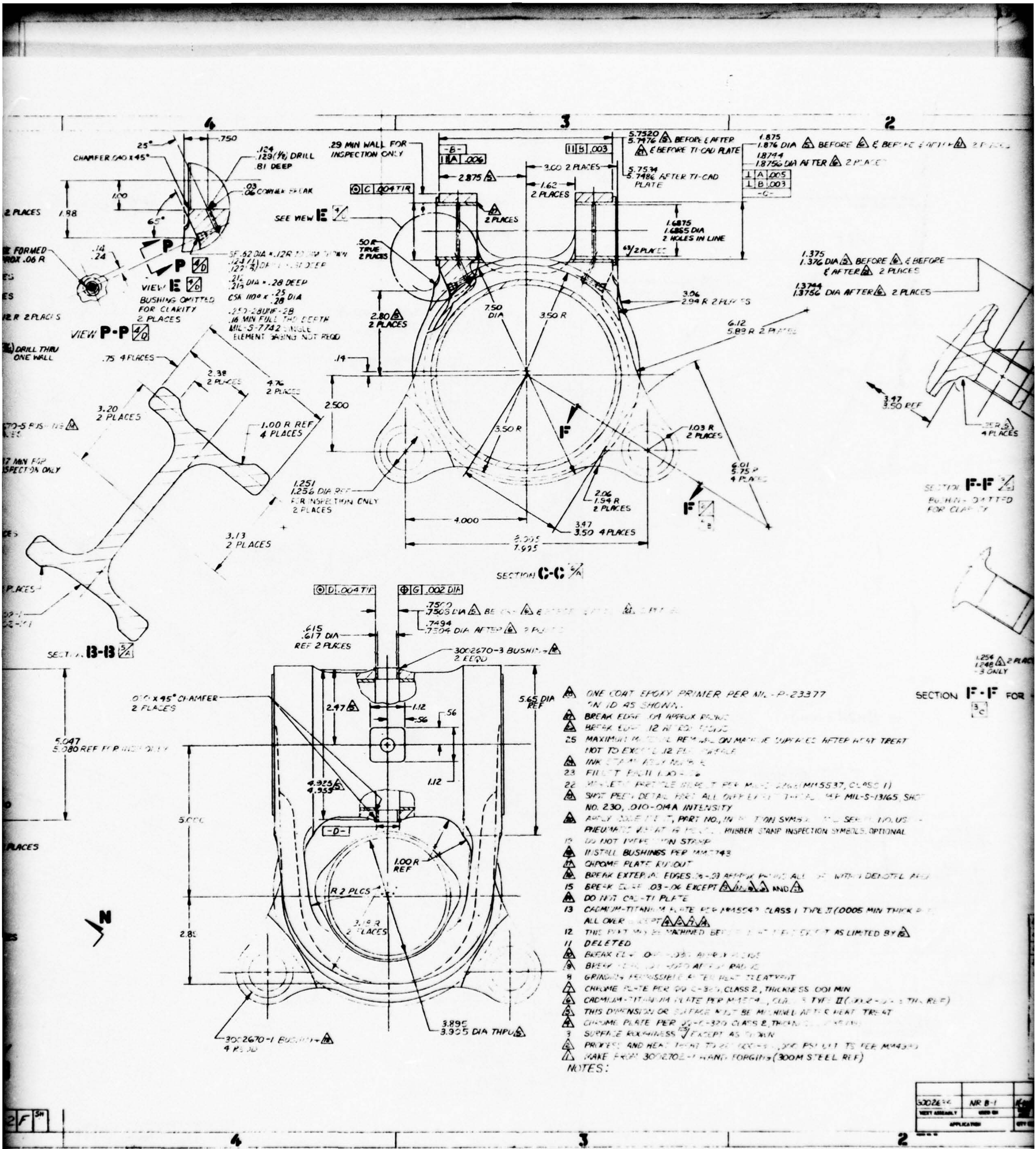

9
8
7
.009 TIR
6.736
6.742 DIA BEFORE & AFTER
2 PLACES
.095
.090 R 2 PLACES
DIA
2.50 ± .15 R
2 PLACES
SECTION L-L 7/C
2.50 ± .15 R
2 PLACES
SECTION M-M 7/C
BLEND SMOOTHLY BETWEEN 2.5R AND 1.0 R FILLET FOR THIS DISTANCE 2 PLACES
10° 2 PLACES
45° 2 PLACES
CONSTANT 2.50 R FILLET FOR THIS DISTANCE 2 PLACES
BLEND SMOOTHLY BETWEEN 2.5 R AND 1.0 R FILLET FOR 1.0 INCH 2 PLACES
SECTION K-K 6/B
57.440
54.41
29.08
.007
27.85
4.50
2 PLACES
4 PLACES
1.50 R
4 PLACES
.007 TIR
-F-
.12 MAX
30°
.50 R
.16
.19 R
6.447
6.453 DIA BEFORE & AFTER
BEFORE & AFTER
.005 TOTAL
6.870 DIA
6.500 DIA
D
6.760 DIA
TAPER AREA
6.354
6.357 DIA BEFORE & BEFORE & AFTER
6.349
6.352 DIA AFTER
.0057 IP
6.380
6.330 DIA
5.60 DIA
TAPER AREA
15.75
3002603 F

γ



7
6
5
5.9354
5.9286 REF FOR INSPECTION ONLY
2 PLACES
BREAK EDGE FORMED BY SF APPROX .06 R
1.00 2 PLACES
.50 2 PLACES
.12 R 2 PLACES
.437
.443 DRILL THRU ONE WALL
2.60
1.00 2 PLACES
.50 2 PLACES
6.960
6.950 DIA
DIA BEFORE
BEFORE & AFTER
DIA AFTER
4.3125
4.3139 DIA BEFORE
4.3119
4.3135 DIA AFTER
.47 MIN FOR INSPECTION ONLY
4.1250
4.1264 DIA
.010
CHAMFER .040 x 45° 2 PLACES
.005
CHAMFER .040 x 45°
1.00
1.88
.14
.24
VIEW P-P
.75 4 PLACES
3.20
2 PLACES
.38 R 12 PLACES
SECTION B-B
11.620
INTERSECTION POINT 4 PLACES
6.01
5.75 R 2 PLACES
PISTON
PISTON
1.38 R
2 PLACES
9° 30'
10.25
9.75 R
4 PLACES
50°
5.047
5.080 REF FOR INSPECTION
6.560 DIA
.75 R
.75 R
4.750
4°
2 PLCS
.88
2
PLCS
1.82
4°
2 PLCS
.170
5.65 DIA 2 PLACES
3.70
35°
4.140
DIA
4.92 2 PLACES
.50 R
1.50 R 2 PLACES
30°
4.86 DIA
.09
.14 CORNER BREAK
6.610 DIA
5.68 DIA
.060
2.330
1.00 2 PLACES
.75 R
.75 R
.12 MAX
4.00 DIA
8.00 R
2 PLACES
5.170 DIA
1.00 R REF
4.30
TAPER AREA
1.43
2 PLACES
9.41 2 PLACES
12.44
14.70
27.36

3


SECTION C-C
SECTION B-B
VIEW P-P
VIEW E
BUSHING OMITTED FOR CLARITY 2 PLACES
SECTION F-F
.29 MIN WALL FOR INSPECTION ONLY
5.7520
5.7476 BEFORE & AFTER
& BEFORE TI-CAD PLATE
5.7534
5.7486 AFTER TI-CAD PLATE
1.875
1.876 DIA BEFORE
1.8744
1.8756 DIA AFTER 2 PLACES
1.6875
1.6865 DIA 2 HOLES IN LINE
1.375
1.376 DIA BEFORE & BEFORE & AFTER 2 PLACES
1.3744
1.3756 DIA AFTER 2 PLACES
7.50 DIA
3.50 R
3.06
2.94 R 2 PLACES
6.12
5.89 R 2 PLACES
1.03 R 2 PLACES
2.06
1.94 R 2 PLACES
3.47
3.50 4 PLACES
4.000
8.005
7.995
1.251
1.256 DIA REF FOR INSPECTION ONLY 2 PLACES
.750
.7505 DIA BEFORE
.7494
.7504 DIA AFTER 2 PLACES
.615
.617 DIA REF 2 PLACES
3002670-3 BUSHING 2 REQD
.010 X 45° CHAMFER 2 PLACES
5.65 DIA REF
5.047
5.080 REF FOR INSP ONLY
3.895
3.905 DIA THRU
3002670-1 BUSHING 4 REQD
ONE COAT EPOXY PRIMER PER MIL-P-23377 ON ID AS SHOWN.
BREAK EDGE .04 APPROX RADIUS
BREAK EDGE .12 APPROX RADIUS
25 MAXIMUM MATERIAL REMOVAL ON MACHINE SURFACES AFTER HEAT TREAT NOT TO EXCEED .12 PER SURFACE
INK STAMP ASSY NUMBER
23 FILLET RADII .10 - .06
22 MAGNETIC PARTICLE INSPECT PER MIL-I-6868/MA5537, CLASS 1
SHOT PEEN DETAIL PART ALL OVER EXCEPT THREADS PER MIL-S-13165, SHOT NO. 230, .010-.014A INTENSITY
APPLY CODE IDENT, PART NO., INSPECTION SYMBOL AND SERIAL NO. USING PNEUMATIC VIBRATING PENCIL. RUBBER STAMP INSPECTION SYMBOLS OPTIONAL
DO NOT INSPECTION STAMP
INSTALL BUSHINGS PER MA4743
CHROME PLATE RUNOUT
15 BREAK EDGE .03-.06 EXCEPT AND
DO NOT CAD-TI PLATE
13 CADMIUM-TITANIUM PLATE PER MA4542 CLASS I TYPE II (.0005 MIN THICK REF) ALL OVER EXCEPT
12 THIS PART MAY BE MACHINED BEFORE HEAT TREAT EXCEPT AS LIMITED BY
11 DELETED
8 GRINDING PERMISSIBLE AFTER HEAT TREATMENT
CHROME PLATE PER QQ-C-320, CLASS 2, THICKNESS .001 MIN
THIS DIMENSION OR SURFACE MUST BE MACHINED AFTER HEAT TREAT
CHROME PLATE PER QQ-C-320 CLASS 2
3 SURFACE ROUGHNESS EXCEPT AS SHOWN
MAKE FROM 3002702-1 HAND FORGING (300M STEEL REF)
NOTES:
NR B-1
APPLICATION

4

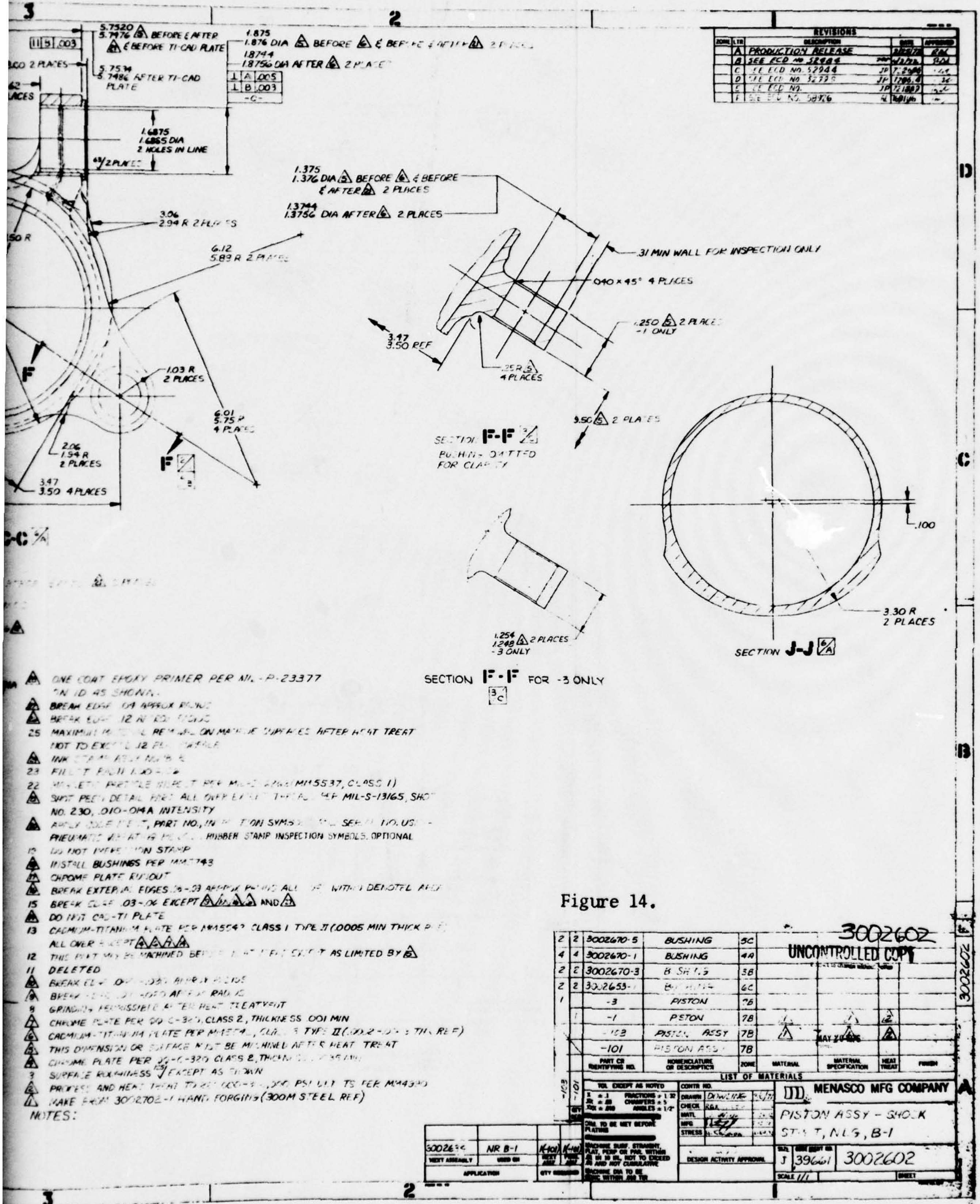
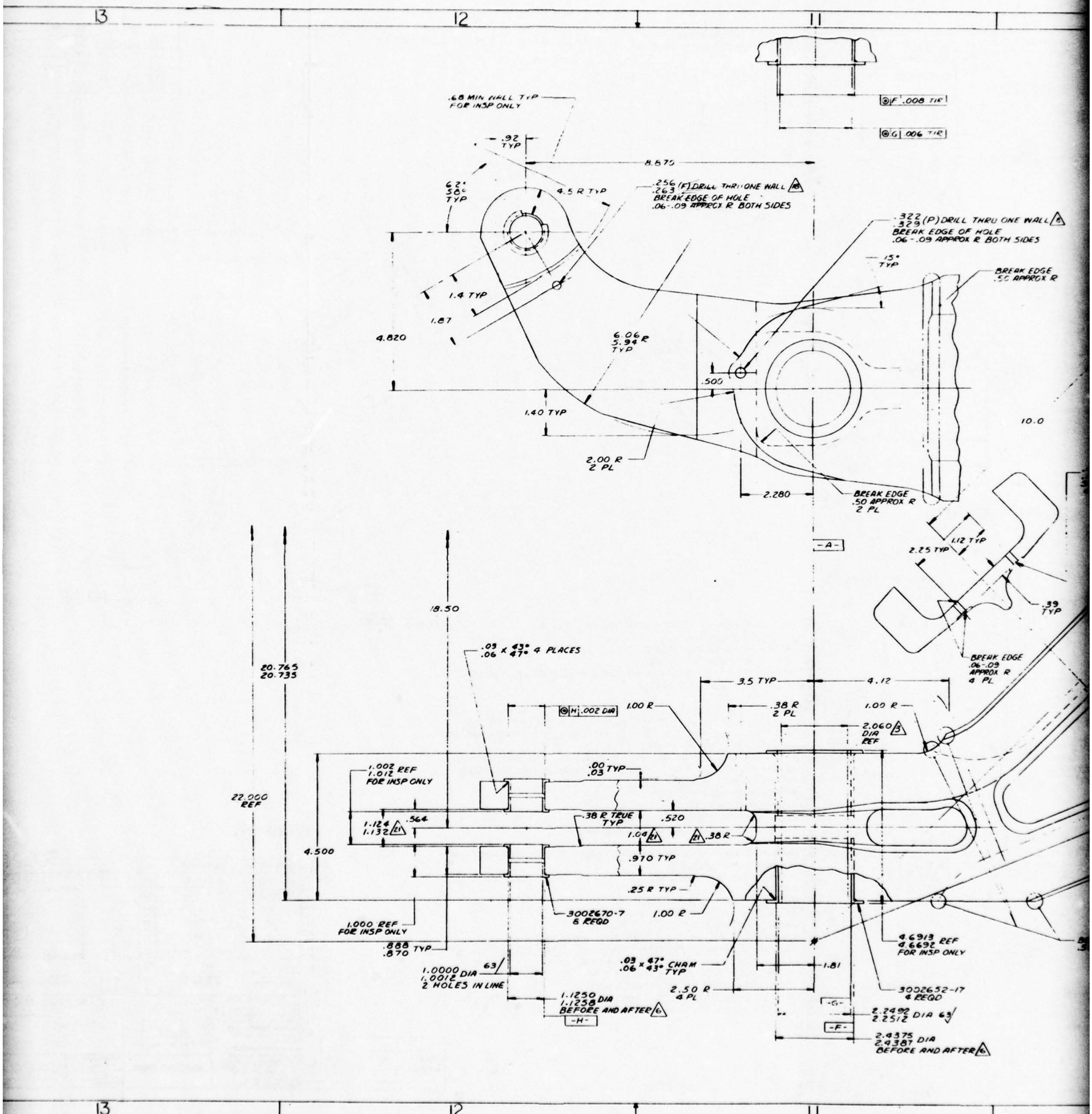
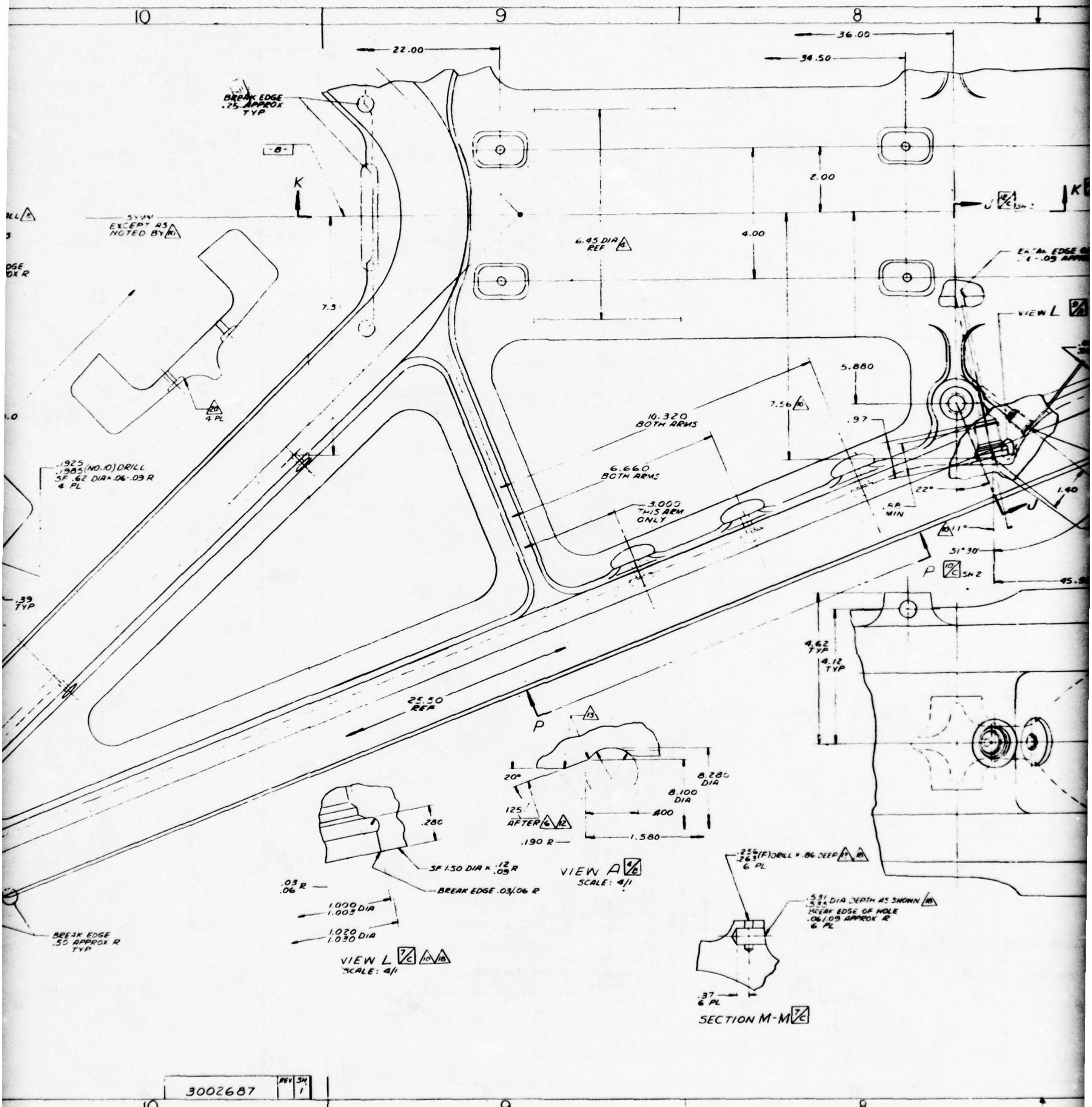

REVISIONS
A PRODUCTION RELEASE
B SEE ECD NO 52944
SECTION F-F
BUSHING OMITTED FOR CLARITY
SECTION F-F FOR -3 ONLY
SECTION J-J
.31 MIN WALL FOR INSPECTION ONLY
.040 x 45° 4 PLACES
3.30 R
2 PLACES
1.375
1.376 DIA BEFORE & BEFORE & AFTER 2 PLACES
1.3744
1.3756 DIA AFTER 2 PLACES
1.6875
1.6855 DIA
2 HOLES IN LINE
3.47
3.50 4 PLACES
ONE COAT EPOXY PRIMER PER MIL-P-23377
INSTALL BUSHINGS PER MA5743
DO NOT CAD-TI PLATE
DELETED
MAKE FROM 3002702-1 HAND FORGING (300M STEEL REF)
NOTES:
3002670-5 BUSHING
3002670-1 BUSHING
3002670-3 BUSHING
PISTON
PISTON ASSY
LIST OF MATERIALS
UNCONTROLLED COPY
3002602
MENASCO MFG COMPANY
PISTON ASSY - SHOCK STRUT, N.L.G., B-1
J 39661 3002602
NR B-1
APPLICATION

Figure 14.

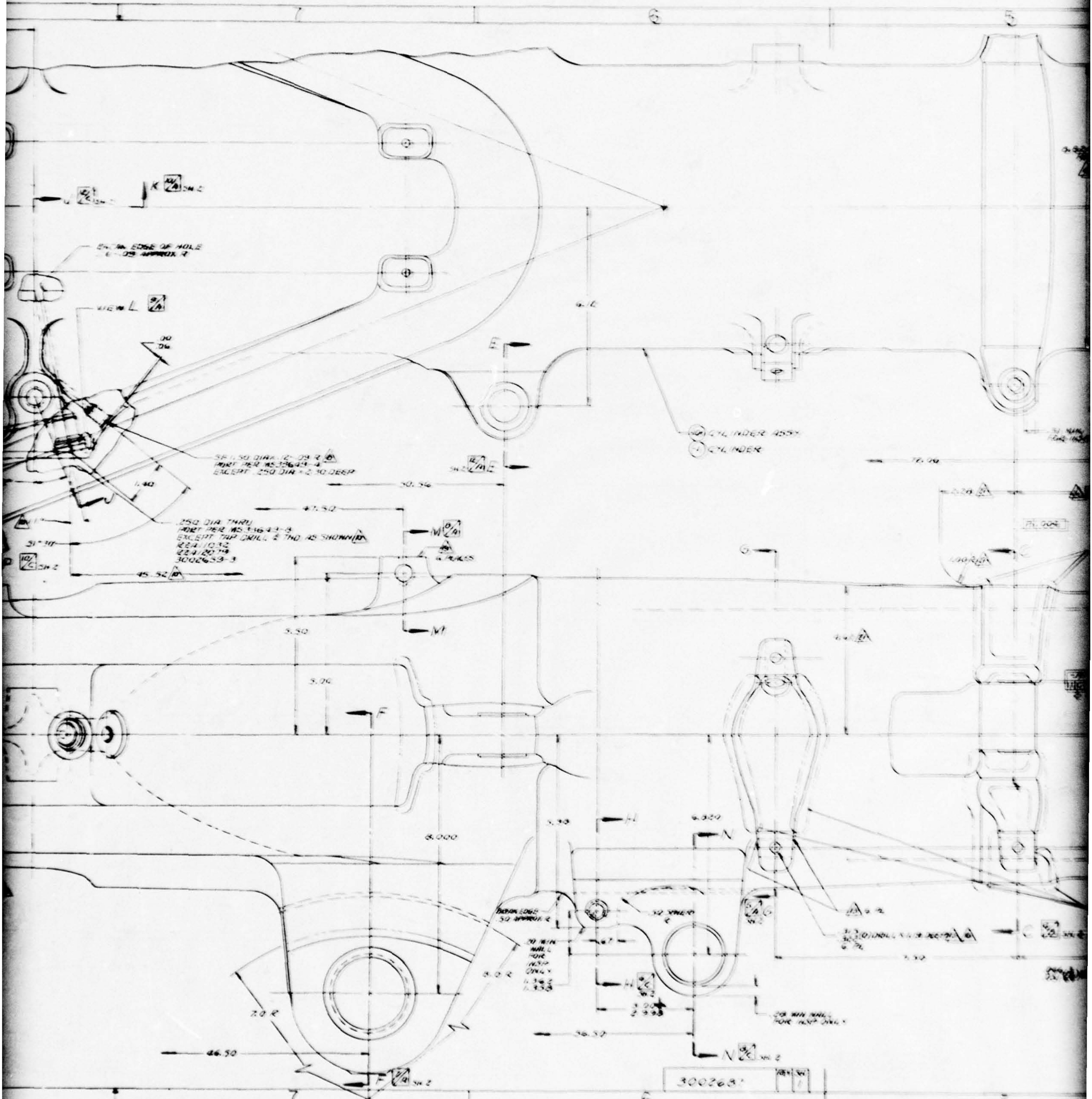
5


13
12
11
.68 MIN WALL TYP
FOR INSP ONLY
F .008 TIR
G .006 TIR
.92
TYP
8.875
62°
58°
TYP
4.5 R TYP
.256
.263 (F) DRILL THRU ONE WALL 18
BREAK EDGE OF HOLE
.06-.09 APPROX R BOTH SIDES
.322
.329 (P) DRILL THRU ONE WALL 8
BREAK EDGE OF HOLE
.06-.09 APPROX R BOTH SIDES
15°
TYP
BREAK EDGE
.50 APPROX R
1.4 TYP
1.87
4.820
6.06
5.94 R
TYP
.500
1.40 TYP
10.0
2.00 R
2 PL
2.280
BREAK EDGE
.50 APPROX R
2 PL
-A-
1.12 TYP
2.25 TYP
.39
TYP
18.50
BREAK EDGE
.06-.09
APPROX R
4 PL
.03 × 43°
.06 × 47° 4 PLACES
20.765
20.735
3.5 TYP
4.12
H .002 DIA
1.00 R
.38 R
2 PL
1.00 R
2.060 3
DIA
REF
22.000
REF
1.002
1.012 REF
FOR INSP ONLY
.00
.03 TYP
1.124
1.132 21
.564
.38 R TRUE
TYP
.520
1.04 21
21 .38 R
4.500
.970 TYP
.25 R TYP
1.00 R
3002670-7
8 REQD
1.000 REF
FOR INSP ONLY
.888
.870 TYP
4.6913
4.6692 REF
FOR INSP ONLY
.03 × 47°
.06 × 43° CHAM
TYP
1.81
1.0000
1.0012 DIA 63
2 HOLES IN LINE
2.50 R
4 PL
3002652-17
4 REQD
1.1250
1.1258 DIA
BEFORE AND AFTER 6
-H-
-G-
2.2492
2.2512 DIA 63
-F-
2.4375
2.4387 DIA
BEFORE AND AFTER 6
13
12
11

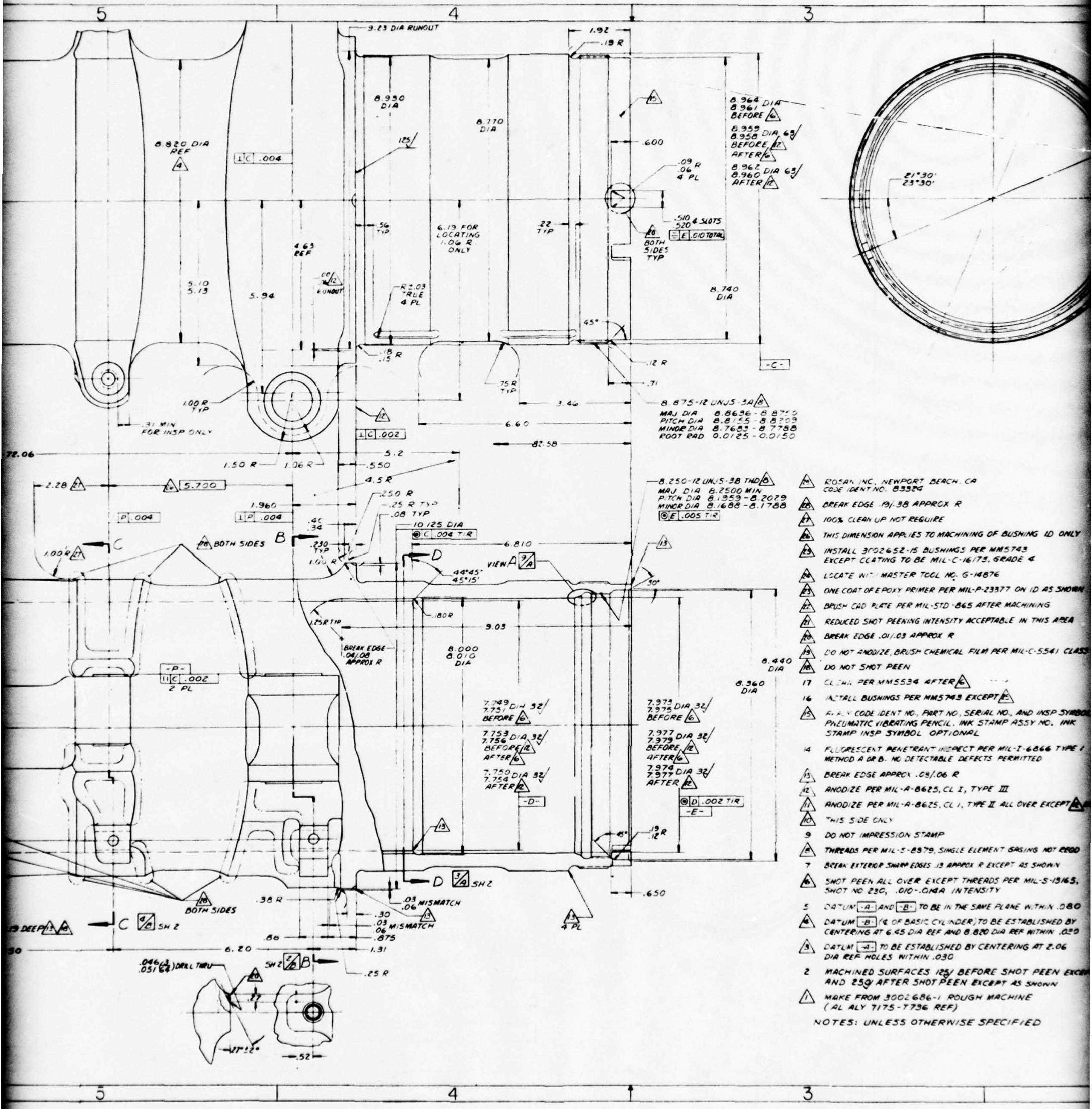
1


10
9
8
22.00
36.00
34.50
BREAK EDGE .25 APPROX TYP
-B-
K
EXCEPT AS NOTED BY
6.45 DIA REF
2.00
4.00
EXTRA EDGE .09 APPROX
VIEW L
5.880
7.56
.97
10.320 BOTH ARMS
6.660 BOTH ARMS
3.000 THIS ARM ONLY
22°
1.40
11°
51°30'
45.5
P
.1925 .1985 (NO.10) DRILL SF .62 DIA x .06-.09 R 4 PL
4 PL
.39 TYP
4.62 TYP
4.12 TYP
25.50 REF
20°
8.280 DIA
8.100 DIA
.125 AFTER
.400
1.580
.190 R
.280
SF 1.50 DIA x .12 .09 R
BREAK EDGE .03/.06 R
VIEW A
SCALE: 4/1
.03 R .06
1.000 DIA 1.003
1.020 DIA 1.030
VIEW L
SCALE: 4/1
BREAK EDGE .50 APPROX R TYP
.256 .263 (F) DRILL x .86 DEEP 6 PL
.531 .534 DIA DEPTH AS SHOWN
BREAK EDGE OF HOLE .06/.09 APPROX R 6 PL
.37 6 PL
SECTION M-M
3002687
REV
SH 1

7

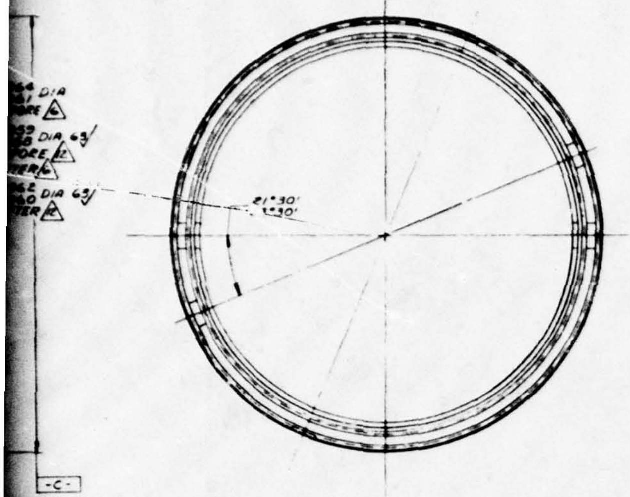

7
6
5
VIEW L
CYLINDER
.250 DIA THRU
50.56
47.50
45.52
5.50
8.000
7.0 R
8.0 R
46.50
36.50

3



5
4
3
9.23 DIA RUNOUT
8.820 DIA REF
8.930 DIA
8.770 DIA
8.964
8.961 DIA
BEFORE
8.959
8.958 DIA 63
BEFORE
AFTER
8.962
8.960 DIA 63
AFTER
21°30'
23°30'
6.19 FOR LOCATING 1.06 R ONLY
4.63 REF
8.740 DIA
8.875-12 UNJS-3A
MAJ DIA 8.8636 - 8.8750
PITCH DIA 8.8155 - 8.8209
MINOR DIA 8.7683 - 8.7788
ROOT RAD 0.0125 - 0.0150
8.250-12 UNJS-3B THD
MAJ DIA 8.2500 MIN
PITCH DIA 8.1959 - 8.2029
MINOR DIA 8.1688 - 8.1788
.005 TIR
10.125 DIA
.004 TIR
VIEW A
BOTH SIDES
8.000
8.010 DIA
8.440 DIA
8.360 DIA
7.749
7.751 DIA 32
BEFORE
7.753
7.756 DIA 32
BEFORE
AFTER
7.750
7.754 DIA 32
AFTER
7.973
7.975 DIA 32
BEFORE
7.977
7.979 DIA 32
BEFORE
AFTER
7.974
7.977 DIA 32
AFTER
.002 TIR
MISMATCH
.046
.051 (2) DRILL THRU
ROSAN INC., NEWPORT BEACH, CA
CODE IDENT NO. 83324
BREAK EDGE .19/.38 APPROX R
100% CLEAN UP NOT REQUIRE
THIS DIMENSION APPLIES TO MACHINING OF BUSHING ID ONLY
INSTALL 3002652-15 BUSHINGS PER MM5743
EXCEPT COATING TO BE MIL-C-16173, GRADE 4
LOCATE WITH MASTER TOOL NO. G-14876
ONE COAT OF EPOXY PRIMER PER MIL-P-23377 ON ID AS SHOWN
BRUSH CAD PLATE PER MIL-STD-865 AFTER MACHINING
REDUCED SHOT PEENING INTENSITY ACCEPTABLE IN THIS AREA
BREAK EDGE .01/.03 APPROX R
DO NOT ANODIZE, BRUSH CHEMICAL FILM PER MIL-C-5541 CLASS
DO NOT SHOT PEEN
17 CLEAN PER MM5534 AFTER 6
16 INSTALL BUSHINGS PER MM5743 EXCEPT 25
CODE IDENT NO., PART NO., SERIAL NO., AND INSP SYMBOL
PNEUMATIC VIBRATING PENCIL. INK STAMP ASSY NO. INK
STAMP INSP SYMBOL OPTIONAL
14 FLUORESCENT PENETRANT INSPECT PER MIL-I-6866 TYPE I
METHOD A OR B. NO DETECTABLE DEFECTS PERMITTED
BREAK EDGE APPROX .03/.06 R
ANODIZE PER MIL-A-8625, CL I, TYPE III
ANODIZE PER MIL-A-8625, CL I, TYPE II ALL OVER EXCEPT
THIS SIDE ONLY
9 DO NOT IMPRESSION STAMP
THREADS PER MIL-S-8879, SINGLE ELEMENT GAGING NOT REQD
7 BREAK EXTERIOR SHARP EDGES .13 APPROX R EXCEPT AS SHOWN
SHOT PEEN ALL OVER EXCEPT THREADS PER MIL-S-13165,
SHOT NO 230, .010-.014A INTENSITY
5 DATUM -A- AND -B- TO BE IN THE SAME PLANE WITHIN .080
DATUM -B- (℄ OF BASIC CYLINDER) TO BE ESTABLISHED BY
CENTERING AT 6.45 DIA REF AND 8.820 DIA REF WITHIN .030
DATUM -A- TO BE ESTABLISHED BY CENTERING AT 2.06
DIA REF HOLES WITHIN .030
2 MACHINED SURFACES 125/ BEFORE SHOT PEEN EXCEPT
AND 250/ AFTER SHOT PEEN EXCEPT AS SHOWN
MAKE FROM 3002686-1 ROUGH MACHINE
(AL ALY 7175-T736 REF)
NOTES: UNLESS OTHERWISE SPECIFIED

4



29 ROSAN INC., NEWPORT BEACH, CA CODE IDENT NO. 83324

28 BREAK EDGE .19/.38 APPROX R

27 100% CLEAN UP NOT REGUIRE

26 THIS DIMENSION APPLIES TO MACHINING OF BUSHING ID ONLY

25 INSTALL 3002652-15 BUSHINGS PER MM5743 EXCEPT COATING TO BE MIL-C-16173, GRADE 4

24 LOCATE WITH MASTER TOOL NO. G-14876

23 ONE COAT OF EPOXY PRIMER PER MIL-P-23377 ON ID AS SHOWN

22 BRUSH CAD PLATE PER MIL-STD-865 AFTER MACHINING

21 REDUCED SHOT PEENING INTENSITY ACCEPTABLE IN THIS AREA

20 BREAK EDGE .01/.03 APPROX R

19 DO NOT ANODIZE, BRUSH CHEMICAL FILM PER MIL-C-5541 CLASS IA

18 DO NOT SHOT PEEN

17 CL[illegible] PER MM5534 AFTER 6

16 INSTALL BUSHINGS PER MM5743 EXCEPT 25

15 [illegible] CODE IDENT NO., PART NO, SERIAL NO., AND INSP SYMBOL WITH PNEUMATIC VIBRATING PENCIL. INK STAMP ASSY NO. INK STAMP INSP SYMBOL OPTIONAL

14 FLUORESCENT PENETRANT INSPECT PER MIL-I-6866 TYPE I METHOD A OR B. NO DETECTABLE DEFECTS PERMITTED

13 BREAK EDGE APPROX .03/.06 R

12 ANODIZE PER MIL-A-8625, CL I, TYPE III

11 ANODIZE PER MIL-A-8625, CL I, TYPE II ALL OVER EXCEPT 12 AND 19

10 THIS SIDE ONLY

9 DO NOT IMPRESSION STAMP

8 THREADS PER MIL-S-8879, SINGLE ELEMENT GAGING NOT REQD

7 BREAK EXTERIOR SHARP EDGES .13 APPROX R EXCEPT AS SHOWN

6 SHOT PEEN ALL OVER EXCEPT THREADS PER MIL-S-13165, SHOT NO. 230, .010-.014A INTENSITY

5 DATUM $\boxed{-A-}$ AND $\boxed{-B-}$ TO BE IN THE SAME PLANE WITHIN .080

4 DATUM $\boxed{-B-}$ (℄ OF BASIC CYLINDER) TO BE ESTABLISHED BY CENTERING AT 6.45 DIA REF AND 8.820 DIA REF WITHIN .030

3 DATUM $\boxed{-A-}$ TO BE ESTABLISHED BY CENTERING AT 2.06 DIA REF HOLES WITHIN .030

2 MACHINED SURFACES 125 BEFORE SHOT PEEN EXCEPT AS SHOWN AND 250 AFTER SHOT PEEN EXCEPT AS SHOWN

1 MAKE FROM 3002686-1 ROUGH MACHINE (AL ALY 7175-T736 REF)

NOTES: UNLESS OTHERWISE SPECIFIED

Figure 15.

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	ZONE	SH	MATERIAL	MATERIAL SPECIFICATION	HEAT TREAT	FINISH
1	RZA12079	INSERT	7C	1	29			
1	RZA11032	LOCK RING	7C	1	29			
1	3002659-3	PACKING	7C	1				
8	3002670-7	BUSHING	12A	1				
4	3002652-17	BUSHING	11A	1				
2	3002670-19	BUSHING	3C	2				
4	3002670-17	BUSHING	6C	2				
2	3002670-15	BUSHING	8C	2				
4	3002670-B	BUSHING	12D	2				
2	3002670-11	BUSHING	1B	2				
2	3002652-15	BUSHING	3C	2				
2	3002652-13	BUSHING	5C	2				
4	3002652-19	BUSHING	7A	2				
4	3002651-1	BUSHING	12B	2				
	-1	CYLINDER	6C	1				
-101	-101	CYLINDER ASSY	6C	1				

LIST OF MATERIALS

UNCO[illegible]LED COPY

MAY 20 1976

NEXT ASSEMBLY	USED ON	NEXT ASSY	FINAL ASSY
3002600	B-1	(-101)	(-101)

APPLICATION — QTY REQUIRED

TOL. EXCEPT AS NOTED: .X ± .1, .XX ± .03, .XXX ± .010; FRACTIONS ± 1/32, CHAMFERS ± 5°, ANGLES ± 1/2°

DIM. TO BE MET BEFORE PLATING

BREAK EDGES .01 TO .03

MACHINE SURF. STRAIGHT, FLAT, PERP OR PAR. WITHIN .01 IN 10 IN., NOT TO EXCEED .05 AND NOT CUMULATIVE

MACHINE DIA TO BE CONC WITHIN .010 TIR

CONTR NO. / DRAWN S.F. [illegible] / CHECK / MATL / MFG / STRESS

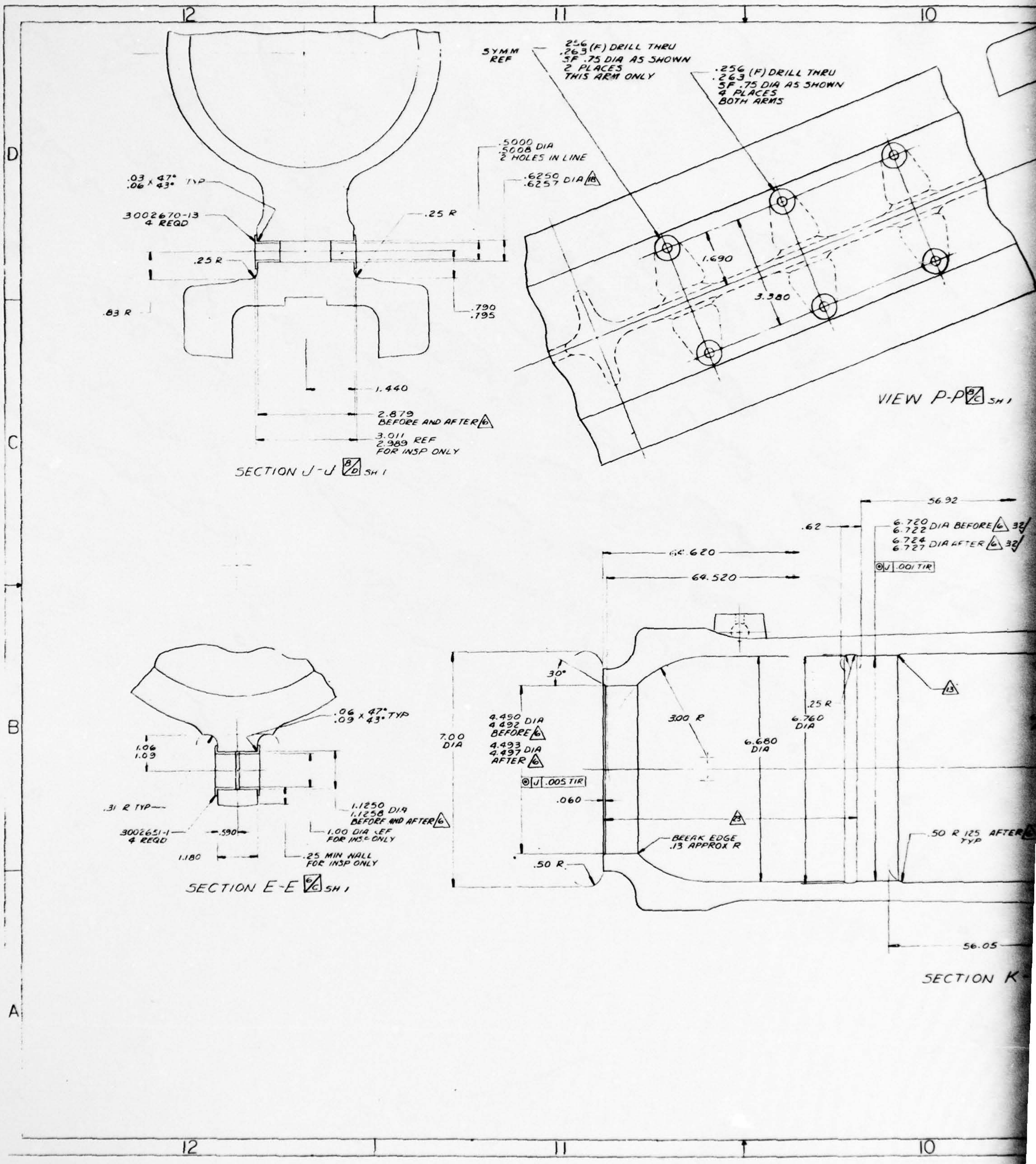
DESIGN ACTIVITY APPROVAL

MENASCO MFG COMPA. CALIFORNIA DIVISION • BURBANK, CA

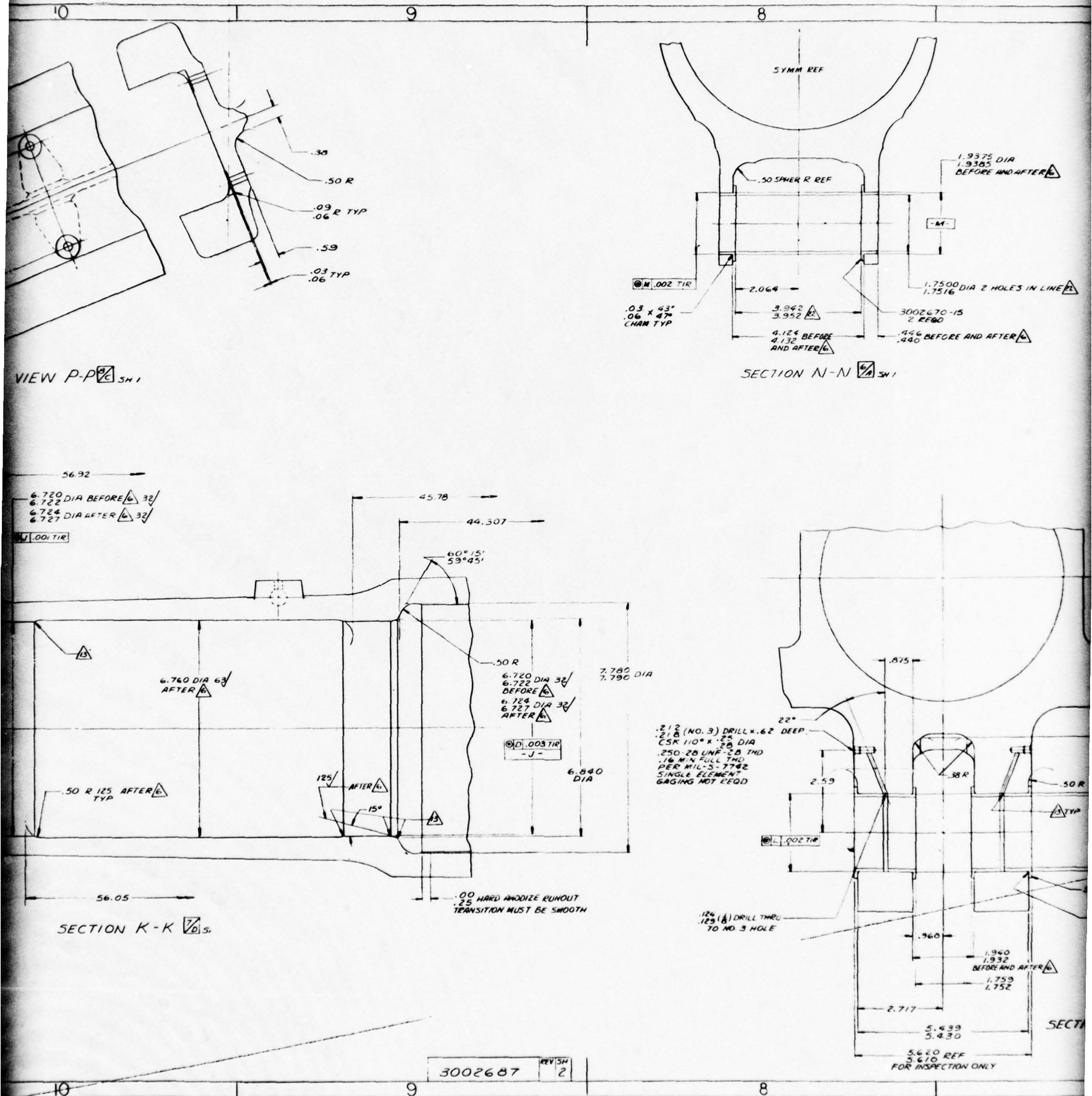
CYLINDER ASSY, SHOCK STRUT-NLG

SIZE J — CODE IDENT NO. 39061 — 300[illegible]87

SCALE 1/1 — SHEET [illegible]



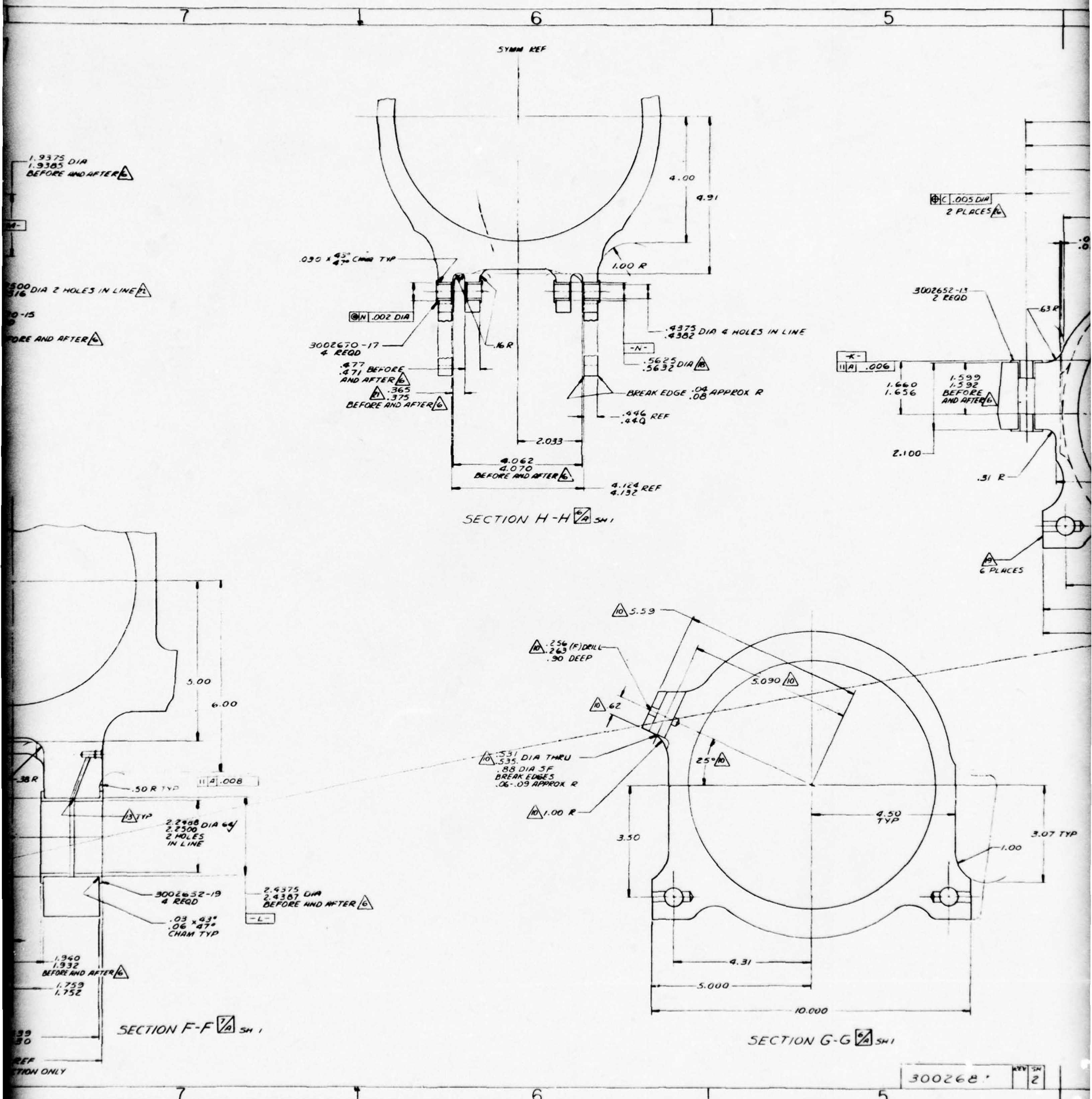
12
11
10
D
C
B
A
SYMM REF
.256 .263 (F) DRILL THRU
SF .75 DIA AS SHOWN
2 PLACES
THIS ARM ONLY
.256 .263 (F) DRILL THRU
SF .75 DIA AS SHOWN
4 PLACES
BOTH ARMS
.5000 .5008 DIA
2 HOLES IN LINE
.6250 .6257 DIA
.03 .06 x 47° 43° TYP
3002670-13
4 REQD
.25 R
.25 R
.83 R
.790 .795
1.440
2.879
BEFORE AND AFTER
3.011 2.989 REF
FOR INSP ONLY
SECTION J-J
1.690
3.380
VIEW P-P
56.92
.62
6.720 6.722 DIA BEFORE
6.724 6.727 DIA AFTER
.001 TIR
64.620
64.520
30°
4.490 4.492 DIA
BEFORE
4.493 4.497 DIA
AFTER
7.00 DIA
.005 TIR
.060
3.00 R
.25 R
6.760 DIA
6.680 DIA
BREAK EDGE
.13 APPROX R
.50 R
.50 R 125 AFTER
TYP
56.05
SECTION K
.06 .09 x 47° 43° TYP
1.06 1.09
.31 R TYP
3002651-1
4 REQD
.590
1.180
1.1250 1.1258 DIA
BEFORE AND AFTER
1.00 DIA REF
FOR INSP ONLY
.25 MIN WALL
FOR INSP ONLY
SECTION E-E

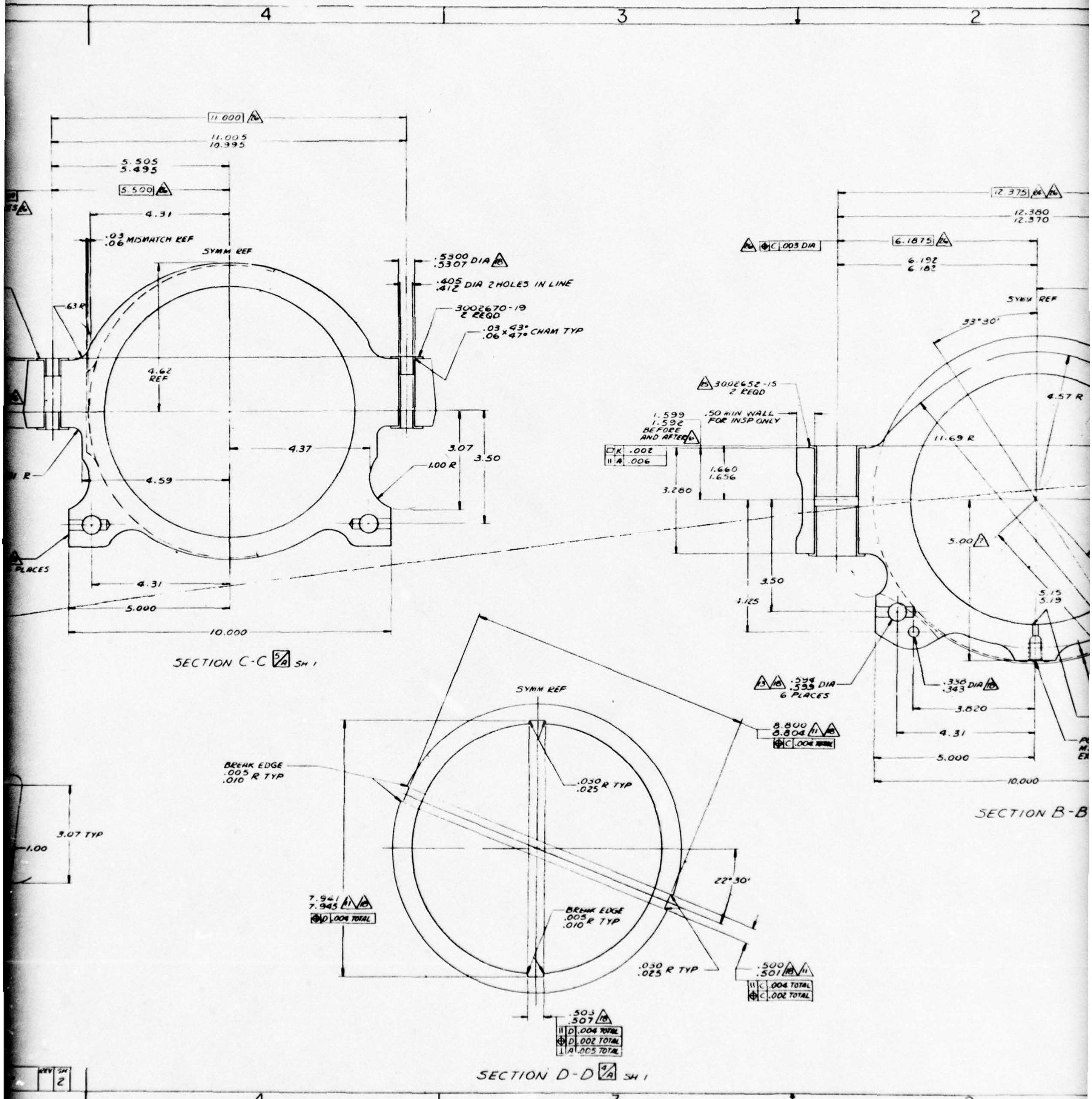


3002687 REV SH 2

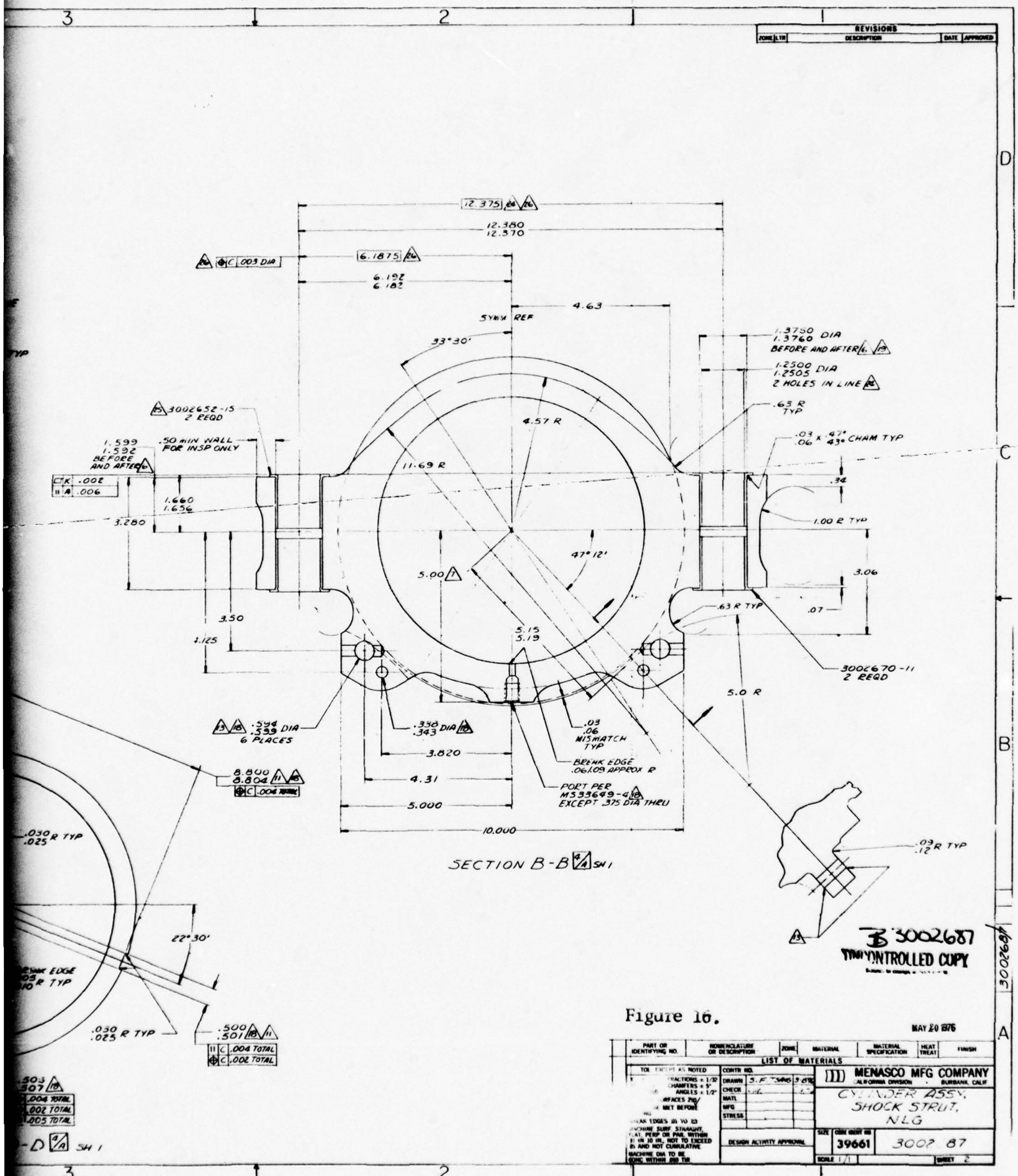
10 9 8

2


7
6
5
SYMM REF
4.00
4.91
1.00 R
.030 x 45° / 47° CHAM TYP
.002 DIA
3002670-17
4 REQD
.16 R
.4375 / .4382 DIA 4 HOLES IN LINE
-N-
.5625 / .5632 DIA
.477 / .471 BEFORE AND AFTER
.365 / .375 BEFORE AND AFTER
BREAK EDGE .04 / .08 APPROX R
.446 / .440 REF
2.033
4.062 / 4.070 BEFORE AND AFTER
4.124 / 4.132 REF
SECTION H-H SH 1
1.9375 / 1.9385 DIA
BEFORE AND AFTER
.2500 / .2516 DIA 2 HOLES IN LINE
BEFORE AND AFTER
.005 DIA
2 PLACES
3002652-13
2 REQD
.63 R
-K-
.006
1.660 / 1.656
1.599 / 1.592 BEFORE AND AFTER
2.100
.31 R
6 PLACES
5.59
.256 / .263 (F) DRILL
.90 DEEP
5.090
.62
.531 / .535 DIA THRU
.88 DIA SF
BREAK EDGES
.06-.09 APPROX R
25°
1.00 R
3.50
4.50 TYP
3.07 TYP
1.00
4.31
5.000
10.000
SECTION G-G SH 1
5.00
6.00
.38 R
.50 R TYP
.008
TYP
2.2488 / 2.2500 DIA
2 HOLES IN LINE
3002652-19
4 REQD
2.4375 / 2.4387 DIA
BEFORE AND AFTER
-L-
.03 x 43° / .06 x 47°
CHAM TYP
1.940 / 1.932
BEFORE AND AFTER
1.759 / 1.752
SECTION F-F SH 1
REF
ONLY
300268
SH 2
3


4
3
2
11.000
11.005
10.995
5.505
5.495
5.500
4.31
.03
.06 MISMATCH REF
SYMM REF
.5300
.5307 DIA
.405
.412 DIA 2 HOLES IN LINE
.63 R
3002670-19
2 REQD
.03 x 43°
.06 x 47° CHAM TYP
4.62
REF
4.37
3.07
3.50
1.00 R
4.59
PLACES
4.31
5.000
10.000
SECTION C-C
SH 1
12.375
12.380
12.370
.003 DIA
6.1875
6.192
6.182
SYMM REF
33°30'
3002652-15
2 REQD
1.599
1.592
BEFORE
AND AFTER
.50 MIN WALL
FOR INSP ONLY
.002
.006
1.660
1.656
3.280
4.57 R
11.69 R
5.00
3.50
1.125
5.15
5.19
.594
.599 DIA
6 PLACES
.338
.343 DIA
3.820
4.31
5.000
10.000
SECTION B-B
SYMM REF
8.800
8.804
.006 TOTAL
BREAK EDGE
.005
.010 R TYP
.030
.025 R TYP
3.07 TYP
1.00
22°30'
7.941
7.945
.004 TOTAL
BREAK EDGE
.005
.010 R TYP
.030
.025 R TYP
.500
.501
.004 TOTAL
.002 TOTAL
.503
.507
.004 TOTAL
.002 TOTAL
.005 TOTAL
REV
SH
2
SECTION D-D
SH 1
4
3
2

4

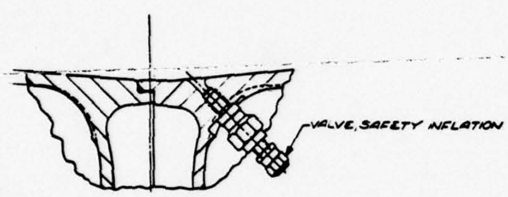


REVISIONS
ZONE LTR DESCRIPTION DATE APPROVED
12.375
12.380
12.370
6.1875
6.192
6.182
C .003 DIA
4.63
SYMM REF
33°30'
1.3750
1.3760 DIA
BEFORE AND AFTER
1.2500
1.2505 DIA
2 HOLES IN LINE
.63 R TYP
.03 x 47°
.06 x 43° CHAM TYP
3002652-15
2 REQD
.50 MIN WALL
FOR INSP ONLY
1.599
1.592
BEFORE AND AFTER
K .002
A .006
4.57 R
11.69 R
1.660
1.656
3.280
.34
1.00 R TYP
47°12'
5.00
3.06
.07
.63 R TYP
3.50
4.125
5.15
5.19
3002670-11
2 REQD
5.0 R
.594
.599 DIA
6 PLACES
.338
.343 DIA
.03
.06
MISMATCH TYP
BREAK EDGE
.06/.09 APPROX R
3.820
4.31
PORT PER
MS33649-4
EXCEPT .375 DIA THRU
5.000
10.000
8.800
8.804
C .004 TOTAL
SECTION B-B SH 1
.030
.025 R TYP
.09
.12 R TYP
22°30'
BREAK EDGE
R TYP
.500
.501
C .004 TOTAL
C .002 TOTAL
.004 TOTAL
.002 TOTAL
.005 TOTAL
SH 1
B 3002687
UNCONTROLLED COPY
3002687
MAY 20 1976
PART OR IDENTIFYING NO.
NOMENCLATURE OR DESCRIPTION
ZONE
MATERIAL
MATERIAL SPECIFICATION
HEAT TREAT
FINISH
LIST OF MATERIALS
MENASCO MFG COMPANY
CALIFORNIA DIVISION · BURBANK, CALIF
CYLINDER ASSY,
SHOCK STRUT,
NLG
DRAWN
CHECK
MATL
MFG
STRESS
DESIGN ACTIVITY APPROVAL
39661
3002687
SCALE 1/1
SHEET 2
3
2
1
D
C
B
A

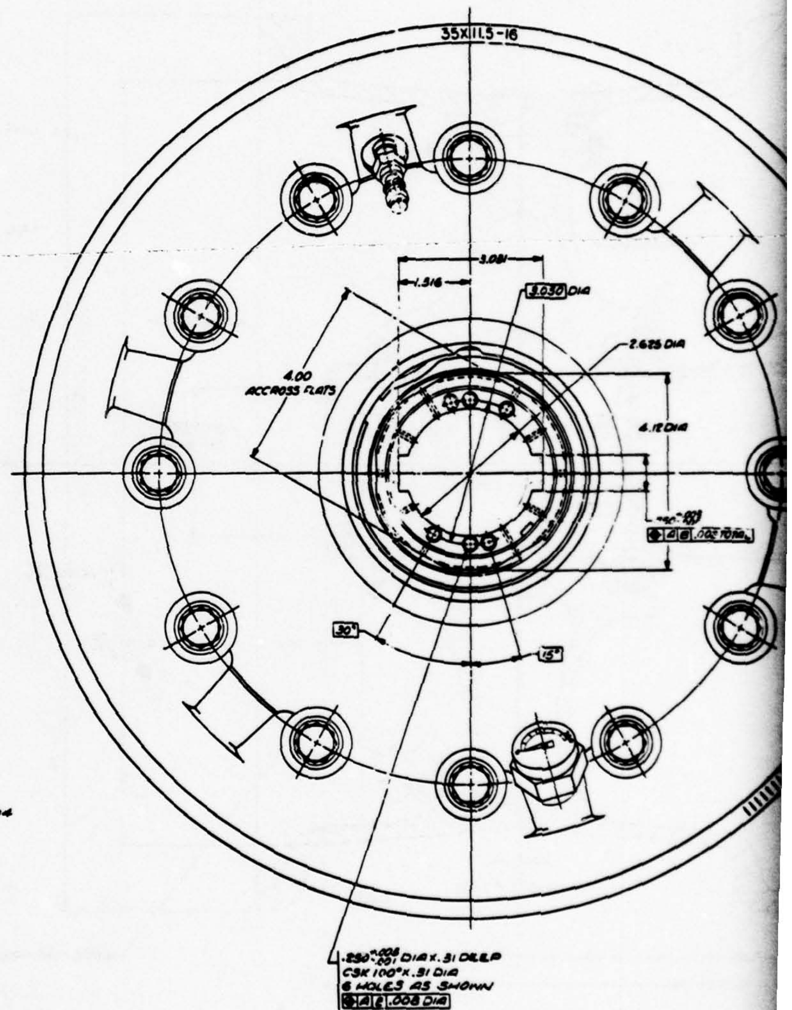
Figure 16.

5

FPE 5-25-72



VIEW SHOWING VALVE INSTL



NOTES:

1. WHEEL CONFORMS TO SPEC MIL-W-5013G AND NAR SPEC L194C2004
2. WHEEL RATED STATIC CAPACITY 23,000 LBS
3. POLAR MOMENT OF INERTIA 18.65 LB FT²
4. TIMKEN ROLLER BEARING CO; OR EQUIV PER SPEC 501-2455

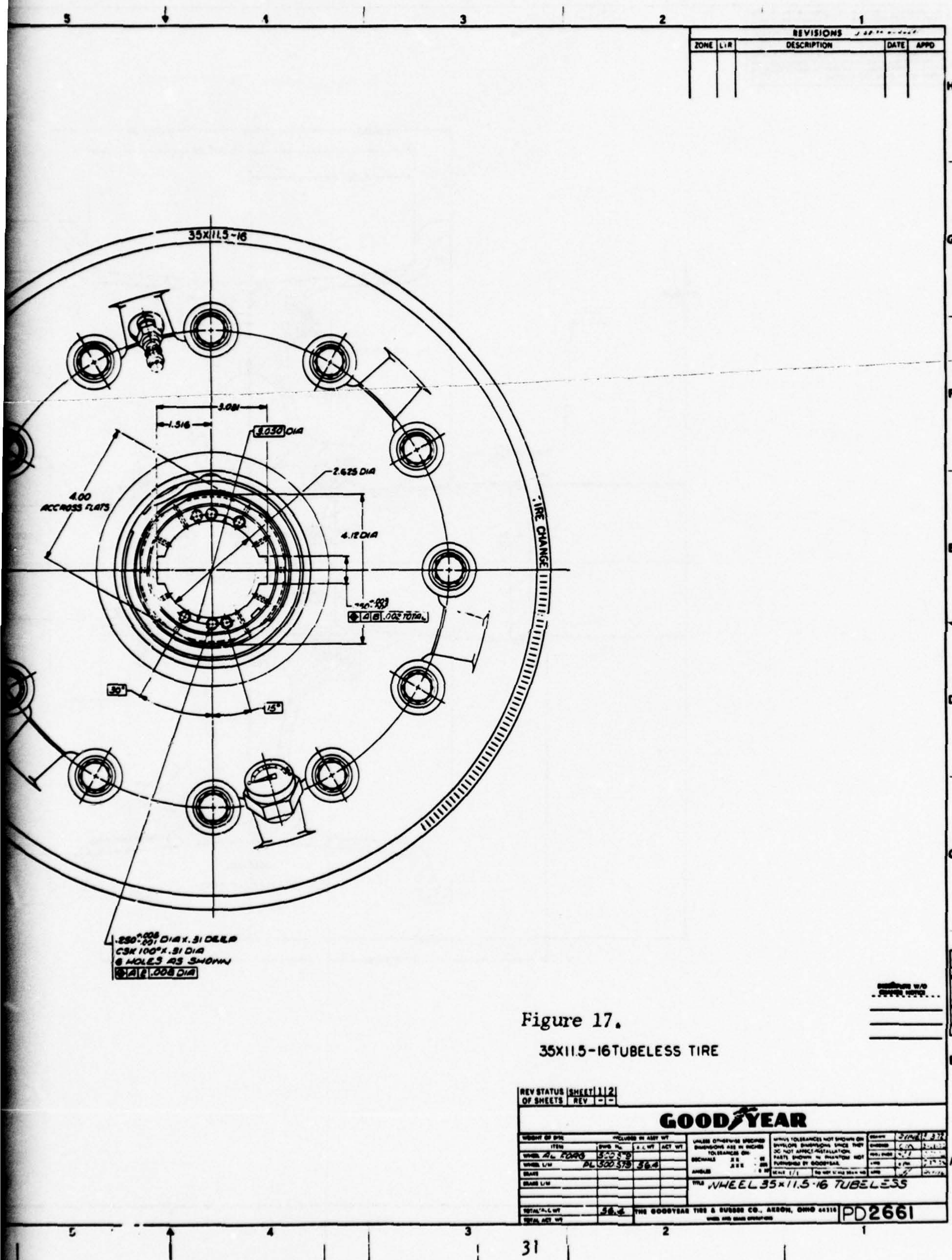
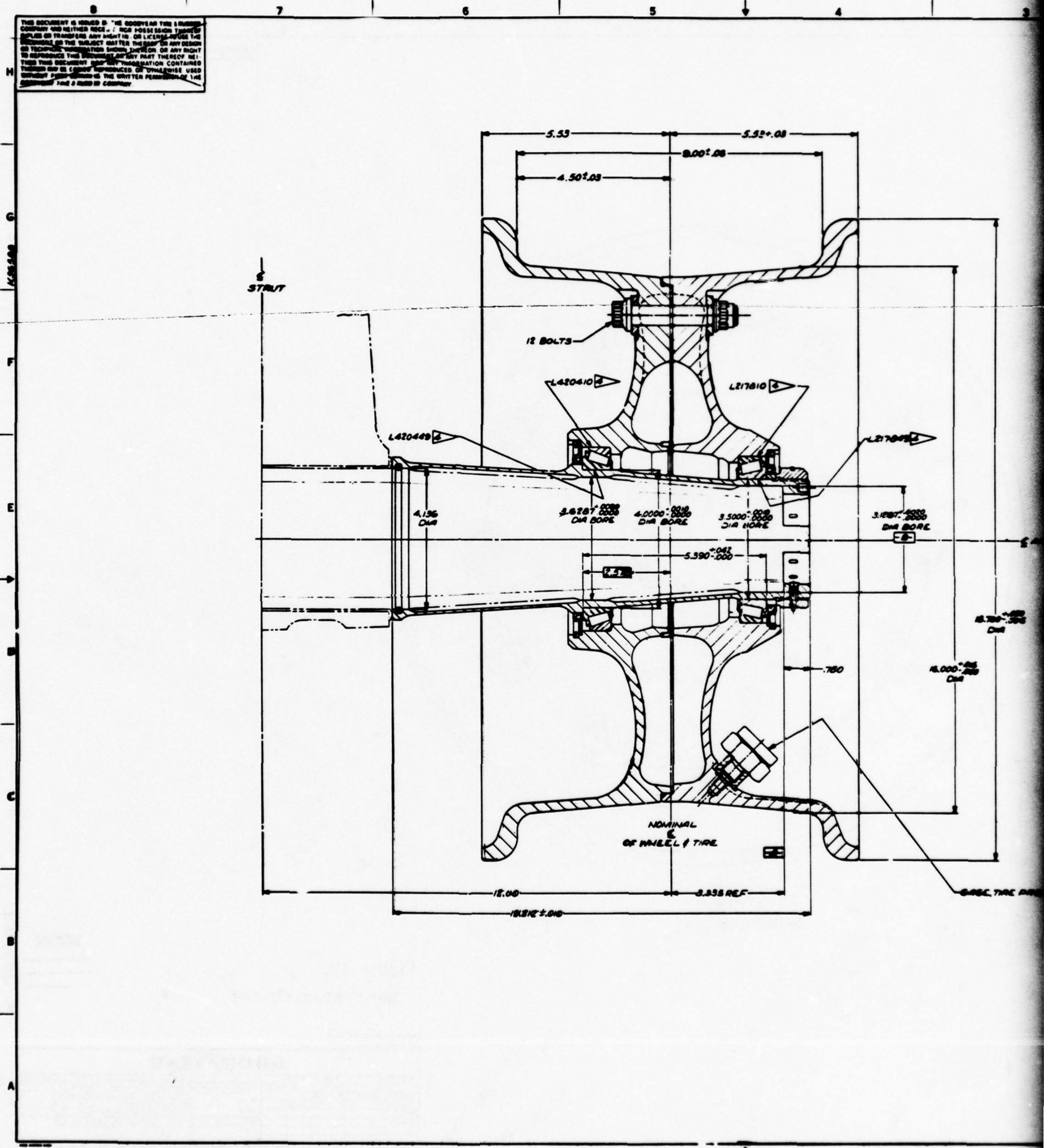


Figure 17.

35X11.5-16TUBELESS TIRE



STRUT
12 BOLTS
L420410
L217810
L420449
L217849
4.136 DIA
2.6287 DIA BORE
4.0000 DIA BORE
3.5000 DIA BORE
3.1281 DIA BORE
5.390
5.53
5.53±.08
9.00±.08
4.50±.03
.780
16.000 DIA
NOMINAL
OF WHEEL & TIRE
18.010
3.338 REF

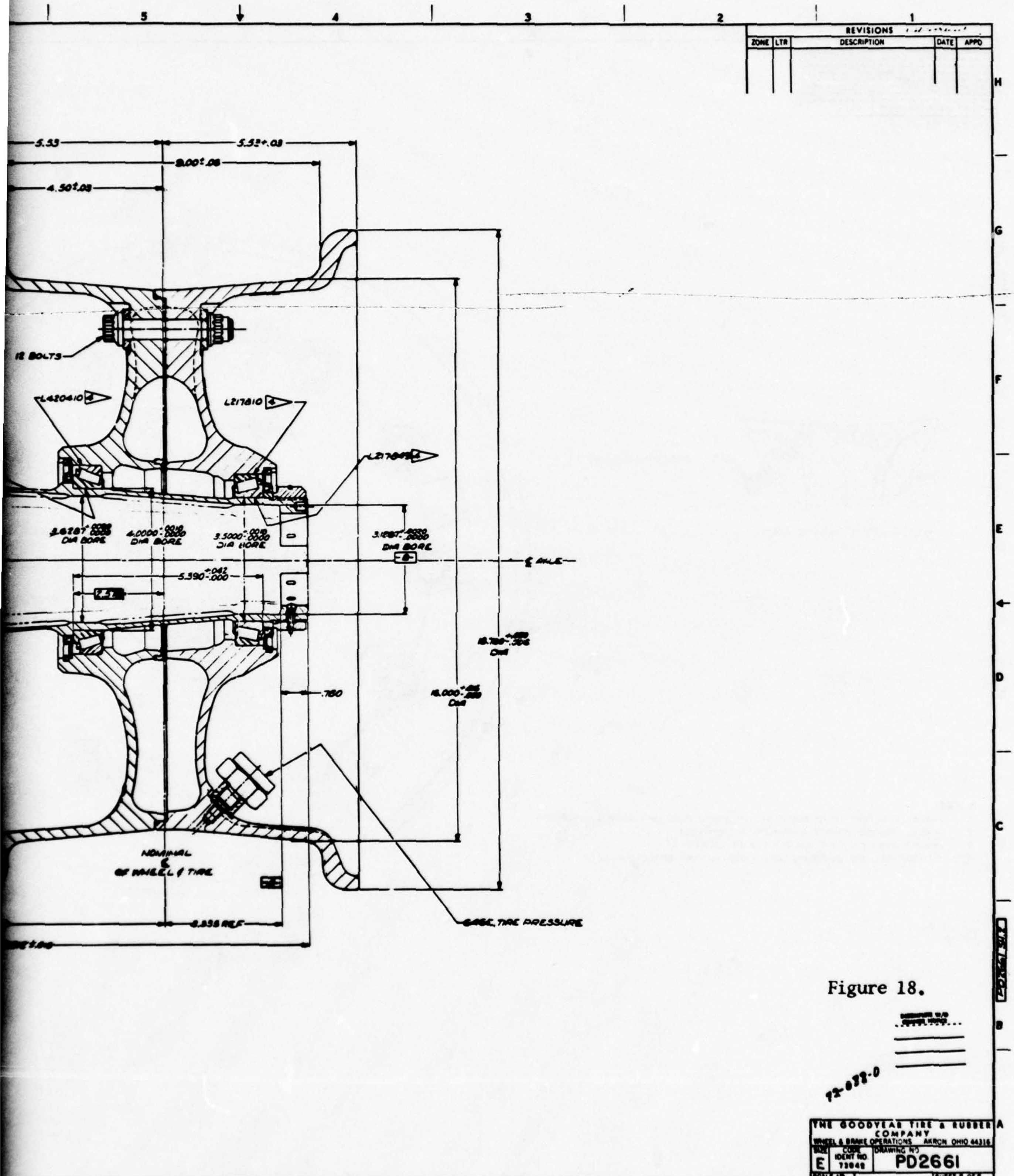

REVISIONS
ZONE
LTR
DESCRIPTION
DATE
APPD
5.53
12 BOLTS
DIA BORE
.750
NOMINAL
OF WHEEL & TIRE
GAGE, TIRE PRESSURE
8.838 REF
THE GOODYEAR TIRE & RUBBER COMPANY
WHEEL & BRAKE OPERATIONS AKRON OHIO 44316
E
PD2661

Figure 18.

3.2.5 External Loads

A summary of nose gear loads for B-1 A/V No. 4, from the B-1 Systems Definition Manual is presented in Appendix C. Included are the following:

1. Landing, Taxi, and Handling Loads
2. Dual Wheel Load Distribution
3. Ultimate Load Determination
4. Fuselage Support Structure Deflections
5. Temperature Condition
6. Drop Test Requirements
7. Actuation System Loads
8. Nose Gear Uplock Loads
9. Nose Gear Door Link Loads
10. Nose Gear Steering Torque
11. Repeated Loads Design Requirements
12. Nose Landing Gear Support Reactions

3.2.6 Component Loads

The loads on B-1 nose gear components for A/V No. 4, as used for structural analysis of the metallic hardware, are presented in this section.

A. Forward Drag Brace
   1. 134500 lb. Tension (ULT)
   2. 136400 lb. Comp. (ULT)

B. Aft Drag Brace
   1. 250500 lb. Tension (ULT)
   2. 25400 lb. Comp. (ULT)

C. Spreader Bar - Drag Brace
   1. Axial Compression of 46600 lb. (ULT) in combination with end moments equal and opposite of 20000 inch- pounds (ULT)
   2. Axial Tension of 47300 lb. (ULT) with 17700 inch - pounds (ULT) end moments

D. Down Lock Links
   1. ± 11000 lb. (Design) axial load, with a transverse load applied to the forward end acting upward of 559 lb.(Limit)
   2. Axial stiffness requirement of lock link and and back-up structure - K 25000 lb/inch

E. Torque Links

1. Apex load $\pm$ 24500 lb. (Design)

F. Strut and trunnion arm loads are shown in figure 19.

G. Piston loads are shown in figure 20.

H. Axle loads are shown in figure 21.

I. Wheel loads are shown in figure 22.

3.2.7 Nose Landing Gear System Weight

The weight of the B-1 nose gear component parts, as given in the Weight Status Report #45, 3 May 1976, is shown in Table IV. Columns under "Weight Status" indicate the percentage of the weight of the component that is "estimated," "calculated," and "actual." It should be noted that many of the parts for A/V No. 4 have not been built and are therefore 100% estimated or calculated.

3.2.8 Environmental Data

The environmental data is presented in Appendix D.

3.2.9 Reliability

The baseline reliability of the B-1 nose landing gear for A/V No. 4 will be based on the reliability of the mechanical equipment installation components of the nose gear, including the wheels but not tires. Table V presents the predicted hardware reliability expressed in "mean time between corrective maintenance action" (MTBCMA).

The predicted MTBCMA for the baseline B-1 nose landing gear is 715.5 flight hours representing a hardware failure rate of 1397.7×10^{-6} flight hours.

3.2.10 Maintainability

The baseline maintainability costs for the B-1 A/V No. 4 nose landing gear system is based on consideration of the following "line replaceable units" (LRU) and "shop replaceable units" (SRU). See Table VI.

The B-1 baseline nose gear maintenance costs are shown in Table VII.

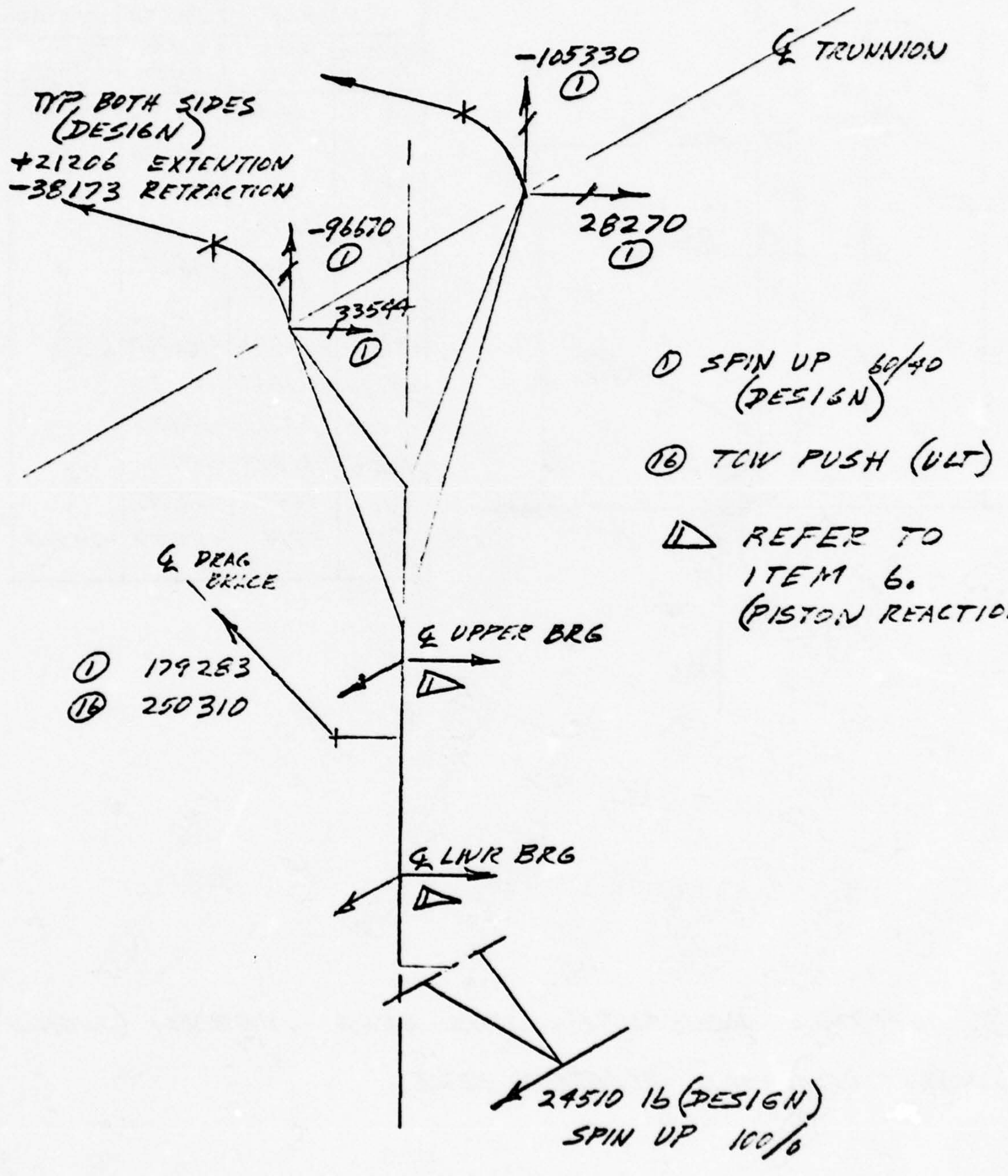
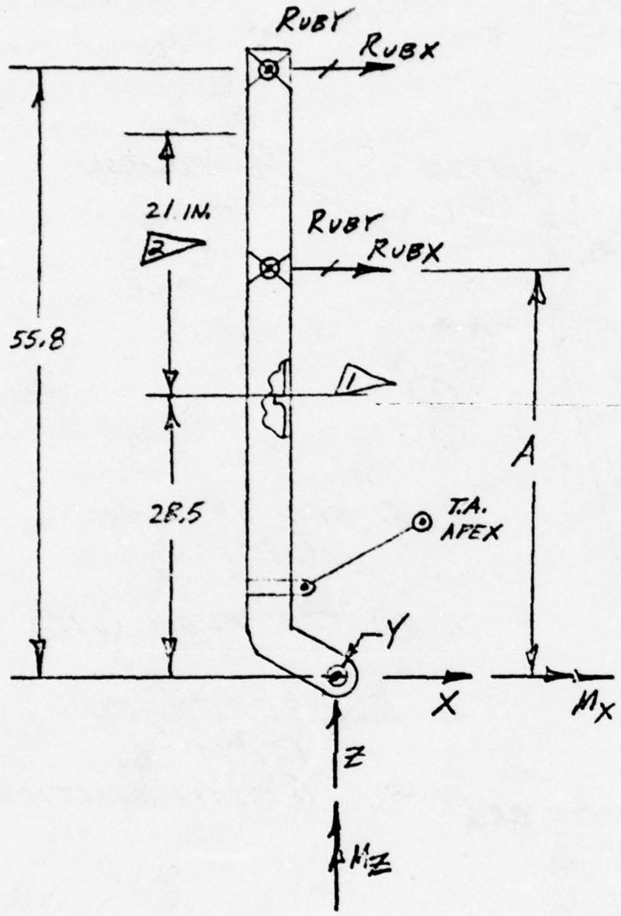


Figure 19. Strut and Trunnion Arm Loads

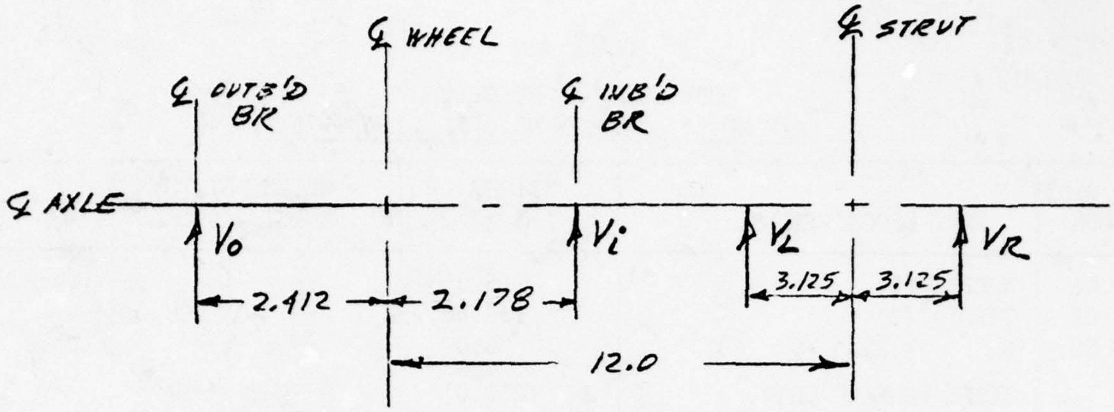


	DYNAMIC TAXI	SPIN UP 60/40	SPIN UP 100/0
	ULT	DESIGN	DESIGN
CRITICAL AREA	LWR END	UPPER END	T.A. ATTACH POINTS
A	24.5	35.35	35.35
X	0	47000	
Y	0	0	
Z	101700	61100	
M_X	1220400	146640	
M_Y	0	0	
M_Z	-508500	-112800	NOT CRITICAL
R_{UBX}	21045	121192	
R_{UBY}	50715	14520	
R_{LBX}	-21897	-169202	
R_{LBY}	-51428	-22797	
T.A. APEX	-714	-8277	-24510

▷2 INTERNAL PRESSURE THIS AREA 1858 PSI (DESIGN)

▷1 VERTICAL LOAD REACTED HERE.

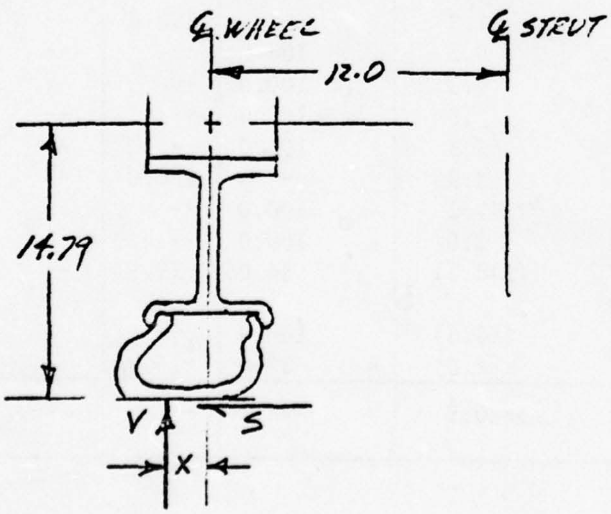
Figure 20. Strut and Piston Loads



	.25 G TURN	DYNAMIC TAXI
V_o	113073	70415
V_i	-57023	31285
V_L	-213180	-262390
V_R	152130	160690

(ULT.) LOADS
ONE TIRE FLAT

Figure 21. Axle Loads



(ULT) LOADS
ONE TIRE FLAT

	.25 G T[illegible]	DYN. TAXI
V	61050	161700
S	15270	0
X	3.00	1.000

Figure 22 . Wheel Loads

TABLE IV

NOSE GEAR WEIGHT DETAILS

A/V NO. 4 - STATUS NO. 45. 3 MAY 1976

AN 9103 CODE	PART DESCRIPTIONS	WEIGHT LBS A/V	WEIGHT STATUS % EST.	% CALC	% ACT
11 B 06	WHEELS (2)	115.0	--	--	100.0
11 B 07	TIRES (2)	138.0	--	100.0	--
11 B 09	N_2	6.0	--	--	100.0
	TOTAL RUNNING GEAR	(259.0)	--	--	--
11 B 34	DRAG BRACES	100.0	100.0	--	--
11 B 38	SHOCK STRUT	586.4	--	6.82	93.17
11 B 40	BEAM ASSY. (AXLE)	31.5	--	--	100.0
11 B 41	TORQUE ARMS (2)	15.6	--	--	100.0
11 B 43	SHIMY DAMP/STEER. CONTROL	184.3	--	3.63	96.36
11 B 47	FITTINGS - BODY	68.0	100.0	--	--
	TOTAL STRUCTURE	(985.8)	--	--	--
11 B	WTB/STRUCTURE	(1244.8)	13.49	14.83	71.66
12 D 13	CONTROLS	4.3	--	23.25	76.74
12 D 22	PLUMBING	6.3	--	100.0	--
12 D 28	FLUID	2.4	--	100.0	--
12 D	STEERING CONTROLS	(13.0)	--	74.61	25.38
12 E 13	CONTROLS	1.0	100.0	--	--
12 E 14	WIRING, CONDUIT, ETC.	14.8	--	100.0	--
12 E 16	MECHANISM	0.3	100.0	--	--
12 E 21	CONTROLS	9.9	100.0	--	--
12 E 22	PLUMBING	7.8	100.0	--	--
12 E 26	ACTUATORS	62.8	100.0	--	--
12 E 28	FLUID	8.9	--	100.0	--
12 E 41	LOCKING MECHANISM	41.2	100.0	--	--
12 E 45	POSITION IND. MECH.	2.0	100.0	--	--
12 E	RETRACT CONTROLS	(148.7)	84.06	15.93	--
12 F	BRAKE OPER. CONTROLS	(10.0)	100.0	--	--
12 G	EMERG'Y. EXT. CONTROLS	(4.0)	85.0	15.0	--
	TOTAL NOSE GEAR	1420.5	---	---	---

TABLE V - B-1 NLG BASELINE HARDWARE RELIABILITY

WORK UNIT CODE	MECHANICAL EQUIPMENT INSTALLATION COMPONENTS	QTY. PER A/C	HARDWARE RATE (PER 10^6 HOURS)
13BAA	SHOCK STRUT	1	256.4
13BAB	DRAG BRACE ASSY, UPPER	1	20.0
13BAC	UPLOCK ASSY.	1	278.6
13BAD	DOORLOCK ASSY. FWD.	1	278.6
13BAE	DOOR SEQUENCE LINK ASSY.	1	51.1
13BAF	BUMPER-WHEEL STOP	2	8.8
13BAH	JURY BRACE	1	10.0
13BAJ	TENSION SPRING FORWARD DOORLOCK	1	8.9
13BAK	BUNGEE, AFT DOORLOCK	1	8.9
13BAL	TENSION SPRING, DOWNLOCK	2	17.8
13BAM	TENSION SPRING, UPLOCK	2	17.8
13BAN	BUNGEE, WHEEL STOP BUMPER	2	17.8
13BAP	DRAG BRACE ASSY. LOWER	1	20.0
13BAQ	TORQUE ARM ASSY.	2	22.0
13BAR	ACTUATION ASSY, LH W/W DOOR	1	10.0
13BAS	ACTUATION ASSY.,RH W/W DOOR	1	10.0
13BDA	WHEEL ASSY., (INCL. FALSE AXLE)	2	361.0

$\Sigma = 1397.7$

TABLE VI

B-1 NOSE LANDING GEAR HARDWARE REPLACEABILITY

NOMENCLATURE	REPLACEABLE CODE	WORK UNIT CODE
Shock Strut - Nose Landing Gear*	LRU	13BAA
Cylinder, Shock Strut - NLG	SRU	13BAA9A
Piston, Shock Strut - NLG	SRU	13BAA9B
Drag Brace, Upper - NLG	LRU	13BAB
Jury Brace - NLG	LRU	13BAH
Drag Brace, Lower - NLG	LRU	13BAP
Torque Arm Assembly-NLG	LRU	13BAQ
Wheel/Tire Assembly-NLG**	LRU	13BDA
Wheel Assembly-NLG	SRU	13DA9A

*Due to the fact that the shock strut assembly must be removed from the aircraft for repair, the complete assembly, consisting of strut (cylinder) and piston, must also be considered, as well as the component parts, for the purposes of this study.

**Only the nose landing gear wheel is to be considered as a composite candidate, however, due to the fact that the wheel/tire assembly is removed from the aircraft for repair, the complete assembly must be considered for the purposes of this study.

TABLE VII

BASELINE - B-1 NOSE LANDING GEAR MAINTENANCE COSTS

NOMENCLATURE	WUC NO.	SPARES COST	MAINTENANCE OFF A/C	MAINTENANCE ON A/C AGE	MAINTENANCE ON A/C PERSONNEL	TOTALS
SHOCK STRUT ASSY.	13BAA (LRU)	204,676	12,476	4,551	56,834	278,537
CYLINDER	13BAA9A (SRU)	51,463	4,731	----	----	56,194
PISTON	13BAA9B (SRU)	65,021	56	----	----	65,077
DRAG BRACE-UPPER	13BAB (LRU)	43,405	43,380	3,501	9,473	99,759
JURY BRACE	13BAH (LRU)	6,933	2,870	431	1,164	11,398
DRAG BRACE-LOWER	13BAP (LRU)	44,536	12,570	674	2,159	59,939
TORQUE ARM ASSY.	13BAQ (LRU)	24,930	8,356	142	2,192	35,620
WHEEL TIRE ASSY.	13BDA (LRU)	----**	17,089 *	356 *	1,686 *	19,131
WHEEL ASSY.	13BDA9A (SRU)	23,570	4,216	----	----	27,786
	TOTAL	464,534	105,744	9,655	73,508	653,441

*Portion of the LRU Cost Attributable to SRU

**Not Spared at LRU Level

SUMMARY: Spares Cost = $464,534
Maint. Cost = 188,907
Grand TOTAL = 653,441

The following assumptions have been made:

1. The current B-1 support concept was used.

   A. Depot repair of the listed items.
   B. Spare LRU's are stocked at the using wing level.

2. The current operational concept for the B-1 was used. Two hundred and ten operational aircraft (7 wings with 30 aircraft each).

   A. One combat crew training squadron wing with 30 aircraft flying 977 hours per month.
   B. Six normal wings with 30 aircraft flying 525 hours per month.

3. The baseline costs were projected in 1976 dollars.

4. The time span of the support is 10 years.

3.2.11 Cost

The baseline cost data for the B-1 nose landing gear hardware for A/V No. 4 is, in part, estimated since no parts have been fabricated. All costs are given in 1976 dollars and for a production quantity of 240 aircraft.

A. Strut Assembly

The nose gear shock strut, consisting of the strut (cylinder) the piston and the torque links, is subcontracted to Menasco Manufacturing Company. Nonrecurring costs have been negotiated, and recurring costs have been estimated for production quantities using the ship 4 through 7 costs and projected using an 89% slope.

1. Nonrecurring Cost	\$ 245,320
2. Recurring Cost	\$ 78,632/shipset

B. Downlock Links

Cost estimates for the upper and lower downlock links were based on price quotes from the material division and the machining cost estimating department. The recurring cost for material is projected on a 95% (Wright) cost reduction curve (CRC) and the machining costs on a 78% CRC.

1. Nonrecurring Cost	\$ 56,587
2. Recurring Cost	\$ 450/ship set

C. Wheel

The wheel is subcontracted to Goodyear Aerospace Corporation and the cost has been negotiated. The production cost reduction slope is assumed to be a very shallow 98% slope.

1. Nonerecurring Cost $ -0- (No design change)
2. Recurring Cost $ 9,408/ship set

D. Drag Braces

The cost estimate for the forward and aft drag braces are based on a supplier quote. The production quantity is projected on a 92% CRC.

1. Nonrecurring Cost $62,660
2. Recurring Cost $10,195/ship set

3.2.12 Life Cycle Costs

The B-1 nose gear baseline life cycle costs have been estimated using the data from the Reliability, Maintainability and Cost sections. The total Life Cycle Cost is $24,702,638, for the mechanical equipment components listed, based on 240 aircraft. Table VIII lists life cycle costs by each major component.

TABLE VIII
LIFE CYCLE COST

(1976 Dollars)

Nomenclature	240 Shipset Implementation (Nonrecurring)	Acquisition (Recurring)	Support
Nose Landing Gear			
1. Shock Strut Assy.			278,537
2. Cylinder			56,194
3. Piston			65,077
4. Torque Link			35,620
	245,320	18,872,000	435,428
Drag Braces			
1. Upper			99,759
2. Lower			59,939
	62,660	2,446,700	159,698
Down Lock (Jury Brace)			
1. Upper			
2. Lower			
	56,587	107,917	11,398
Wheel			
(Wheel Assembly)			19,131
1. (shipset) (wheel)	0	2,258,013	27,786
TOTAL	364,567	23,684,630	653,441 =

GRAND TOTAL $24,702,638, TOTAL LIFE CYCLE COST

SECTION IV

DESIGN CONCEPTS

The five conceptual design studies for Phase I presented in this section have been made to determine the potential of using composite material for the B-1 nose landing gear. Studies have been made for three design concepts each having different constraints. The concepts are:

1. Substitution - Constrained by form, fit and function.
2. Modified - Constrained by fit and function.
3. Redesigned - Constrained by function only.

4.1 MATERIAL SELECTION

The baseline material system selected for this study effort is intermediate strength graphite/epoxy. The intermediate strength graphite fiber offers a good balance between fiber characteristics and fiber cost. The use of a high temperature, 275 to 350 F, service epoxy is indicated for the composite matrix in order to meet the environmental requirements for the B-1.

The selection of composite landing gear materials for this study program was based on design considerations and material property parameters. These design considerations and property parameters are presented in table IX.

Fiber strength and modulus provide a measure of composite material mechanical property potential, and the ultimate tensile elongation indicates the potential overload capacity. Matrix temperature limitations and resistance to environmental degradation are resin selection criteria. Ultimate elongation of the resin also has been considered for maximum composite performance, and high transverse lamina elongation generally result in:

First-ply failure strains above the static design limit load.
Reduced composite notch sensitivity.

Matrix processability will influence composite properties, transverse strain capacity, and laminate reproducibility. Prepreg resins exhibiting good tack drape and shelf life characteristics that can be molded into low void composites will improve composite mechanical properties and fabrication economics.

The selection of landing gear component composite materials includes consideration of the various reinforcements. In addition to the various candidate types of graphite fiber, nongraphitic fibers such as Kevlar 49, S-glass, and

TABLE IX . COMPOSITE LANDING GEAR MATERIAL SELECTION PROPERTY CONSIDERATIONS

- Static loading
  - Load direction
  - Stiffness requirement
  - Factor of safety
  - Viscoelastic considerations
- Failure criteria
  - Strain
  - Strength
- Dynamic Loading
  - Fatigue life
  - Impact
  - Fracture Toughness
- Environment
  - Temperature
  - Compatibility
  - Corrosion
  - Moisture
- Fiber
  - Strength
  - Modulus
  - Tensile strain
  - Matrix compatibility
- Resin
  - Temperature limitations
  - Transverse tensile strain
  - Processability
  - Environmental compatibility
- Composite
  - Laminate orientation
  - Configuration mechanical properties
  - Coefficient of expansion
  - Initial failure strain
  - Coefficient of friction

boron has been considered for this program. Orthotropic laminate mechanical properties for typical 60-percent fiber volume composite materials are presented in table X. The composite properties presented indicate an average unidirection (0°) tensile strength of 230 (+30) KSI for all the reinforcements with the exception of HM graphite fiber. The reinforcements, other than graphite, are high strength structurally efficient materials exhibiting completely different elastic constants, physical characteristics, and thermal properties.

The coefficient of thermal expansion of various composite materials and isotropic materials are presented in table XI. The unidirectional laminate coefficients provide an indication of range of values obtainable by tailoring the laminate to a desired value. The use of high thermal coefficient materials, such as aluminum, will be avoided to minimize thermally induced internal stresses. Titanium and low thermal expansion steels will be favored for mating to "tailored" composites with minimal thermal mismatch.

Material properties for various candidate materials are given in tables X and XII. Typical properties for continuous fiber reinforced laminates in an epoxy matrix are shown in table X. Table XII gives typical properties for chopped fiber reinforced compressed molded thermoset materials.

The third edition of the Advanced Composite Design Guide has served as the basis for unidirectional oriented ply composite mechanical properties. The orientations selected during this study consider such factors as predicted laminate strain to initial failure, coefficient of thermal expansion, environmental knock-down factors, and etc.

The environmental requirements for the nose wheel landing gear are shown in Section III. The thermal exposure temperature of 265° F for the gear require that, as a minimum, a 350° F curing composite matrix resin be utilized. Other environmental conditions are not critical to the selection of a baseline composite material system. The most significant environmental effect to be considered is the combined effect of moisture on the mechanical properties. The "wet" design allowables established for graphite/epoxy in various advanced composite application programs are to be utilized for this study.

4.2 CONCEPT 1 - SUBSTITUTION

The design concepts in this study are limited to composite material substitution for the existing metal hardware on a component by component basis. The composite hardware must have identical key dimensions to satisfy the form, fit and function of the metal baseline components.

TABLE X
TYPICAL COMPOSITE PROPERTIES
UNIDIRECTIONAL - 60-PERCENT FIBER VOLUME

Property	Material				
	AS/ Epoxy	HMS/ Epoxy	Kevlar/ Epoxy	S-Glass/ Epoxy	Boron/ Epoxy
Elastic constants (psi x 10^6)					
0° tensile modulus	19.8	28.0	12.5	8.8	30.0
0° compression modulus	16.0	24.8	10.5	7.4	30.0
90° tensile modulus	1.4	1.4	0.8	1.9	2.7
90° compression modulus	1.4	1.4	0.8	1.9	2.7
Poisson's ratio	0.30	0.30	0.325	0.30	0.21
In-plane shear modulus	0.65	0.65	0.4	0.55	0.70
Thermal expansion coefficients (in./in./°F x 10^{-6})					
0° coefficient	-0.2	-0.3	-2.2	6.0	2.3
90° coefficient	15.0	13.0	32.0	20.0	10.6
Ultimate strains (%)					
0° tensile	1.15	0.5	1.8	2.8	0.65
0° compression	1.40	0.6	0.3	1.7	—
90° tensile	0.63	0.4	0.57	0.33	0.40
90° compression	1.90	1.0	3.1	2.4	—
Ultimate strenghts (psi x 10^3)					
0° tensile	220.0	145.0	210.0	250.0	200.0
0° compression	220.0	145.0	38.0	115.0	350.0
90° tensile	8.4	6.0	2.8	5.1	10.4
90° compression	30.0	25.0	20.0	25.0	40.0
In-plane shear	18.6	8.0	6.0	6.0	15.3
Density (lb/in.^{3})	0.056	0.057	0.050	0.072	0.072

TABLE XI

COEFFICIENT OF THERMAL EXPANSION

(α IN. 10^{-6} IN./IN./°F)

Material	Unidirectional Laminate Parallel	Unidirectional Laminate Perpendicular	Isotropic Material
S-glass*	3.5	11	–
Kevlar 49*	-2.0	30	–
LHS*	-0.1 -0.5	14	–
HM*	-0.5	15	–
UHM*	-0.8	17	–
Boron*	2.3	8	–
Aluminum	–	–	12 - 14
Steel	–	–	6 - 10
Titanium	–	–	4 - 7
Epoxy resin	–	–	30 - 50

*60-percent fiber volume epoxy composite

TABLE XII

TYPICAL PROPERTIES FOR COMPRESSION-MOLDED CHOPPED-FIBER/EPOXY COMPOSITES

Mechanical Property	Material AS/Epoxy	HMS/Epoxy	Boron/Epoxy	Glass/Epoxy
Tensile strength (psi x 10^3)	30.0	30.0	35.0	27.0
Tensile modulus (psi x 10^6)	6.7	8.0	10.0	3.0
Compressive strength (psi x 10^3)	40.0	35.0	60.0	38.0
Bearing strength (psi x 10^3)	50.0	–	65.0	–
Density (lb/in.^{3})	0.057	0.059	0.076	0.065

The B-1 nose landing gear hardware has been studied to determine whether individual parts could be made from composite material and still satisfy the above constraints. In several cases, investigation showed that sections of some parts should remain metal to accommodate the high loads within the "form" constraint, but it was felt that these parts could still be viable candidates using spliced metal/composite construction.

Components chosen for study included: drag braces, forward and aft; down locks, forward and aft; the torque link; strut trunnion arms; and the wheels. See figure 23.

4.2.1. Forward Drag Brace

The drag braces attach to the forward side of the strut and stabilize it in a fore and aft direction. The drag brace folds for stowage about a center pivot. The forward section is dual and connects the center pivot to both wheel well side walls, see figure 23. The loads in the forward drag brace are axial and the tension load is 134,500 pounds ultimate and the compression load is 136,400 pounds ultimate.

The baseline B-1 part, figures 9 and 10, is a forging made from HP 9-4-30 steel which is heat treated to 220,000 to 240,000 psi. The part is cylindrical with lug ends which connect the part to the upper structure supports and to the aft drag brace.

The design concept shown in figure 24 is an example of the spliced metal/composite construction previously referred to. Two end fittings are made of 220,000 to 240,000 psi heat treated steel. The lugs on these fittings are identical to the baseline so that they can react the high loads and mate with the adjoining parts without changes. These end fittings are multi-step lap spliced to the cylindrical composite section. This 37.3 inch long composite tube is laminated graphite epoxy (Gr/Ep) using more than 80% 0° (longitudinal) plies and less than 20% $\pm$ 15° (spiral wound) plies. This composite tube is co-cured to the end fittings using a 5-inch long multi-step lap splice.

4.2.2 Aft Drag Brace

The aft drag brace is a single structural component which connects the apex of the dual forward drag braces to the strut, see figure 23. The loads in the aft drag braces are axial and the tension load is 250,500 pounds ultimate and the compression load is 254,000 pounds ultimate.

The baseline B-1 aft drag brace, figures 7 and 8, is an "I" section forging made from MIL-S-8844 Class 3 300M steel which is heat treated to 280,000 to 300,000 psi. The "I" section terminates in end lugs which are

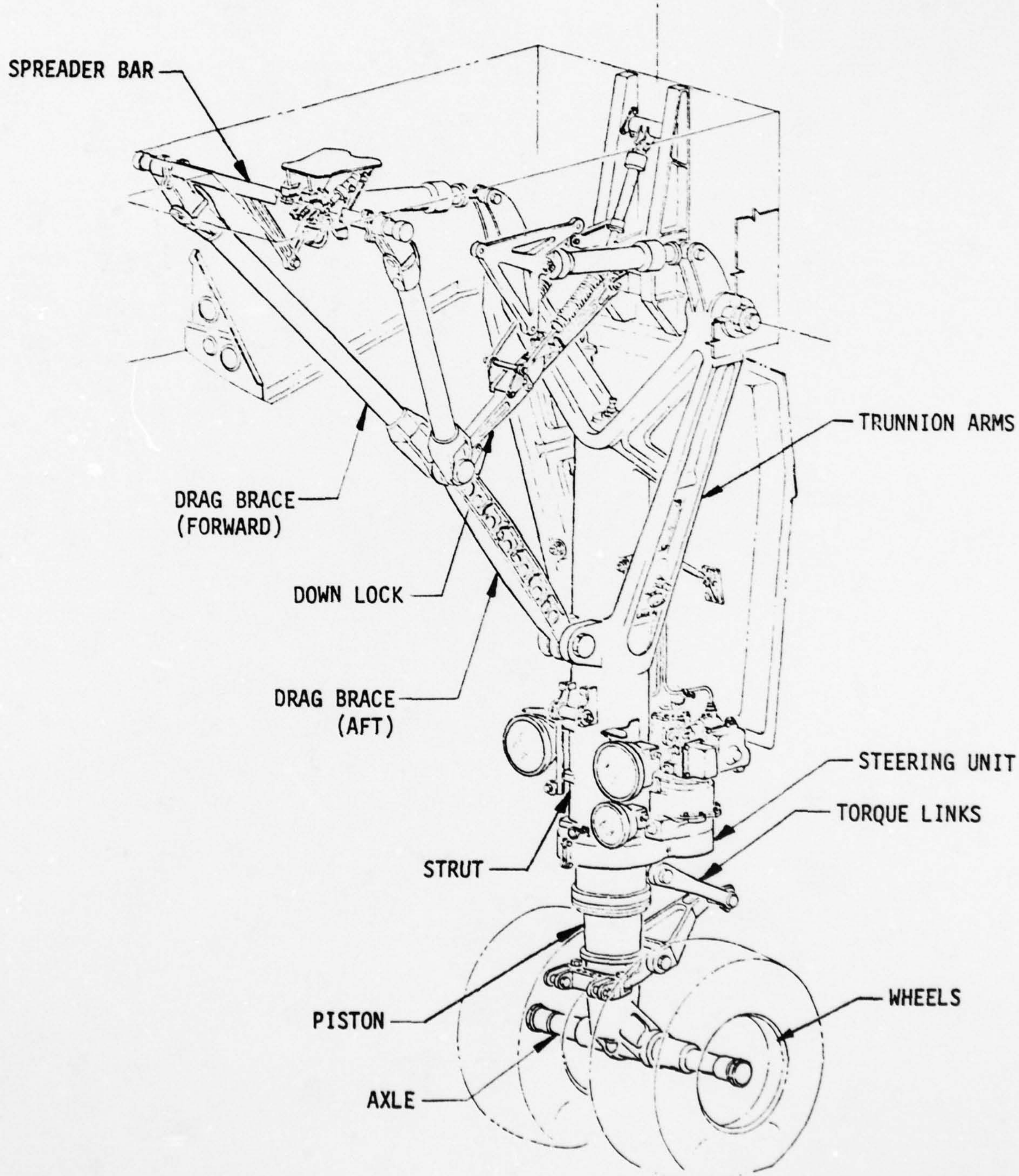
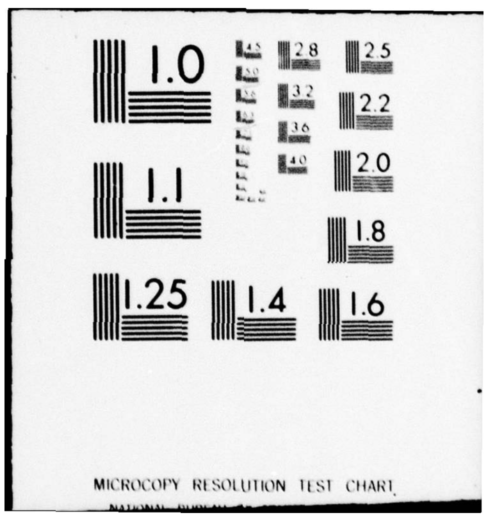
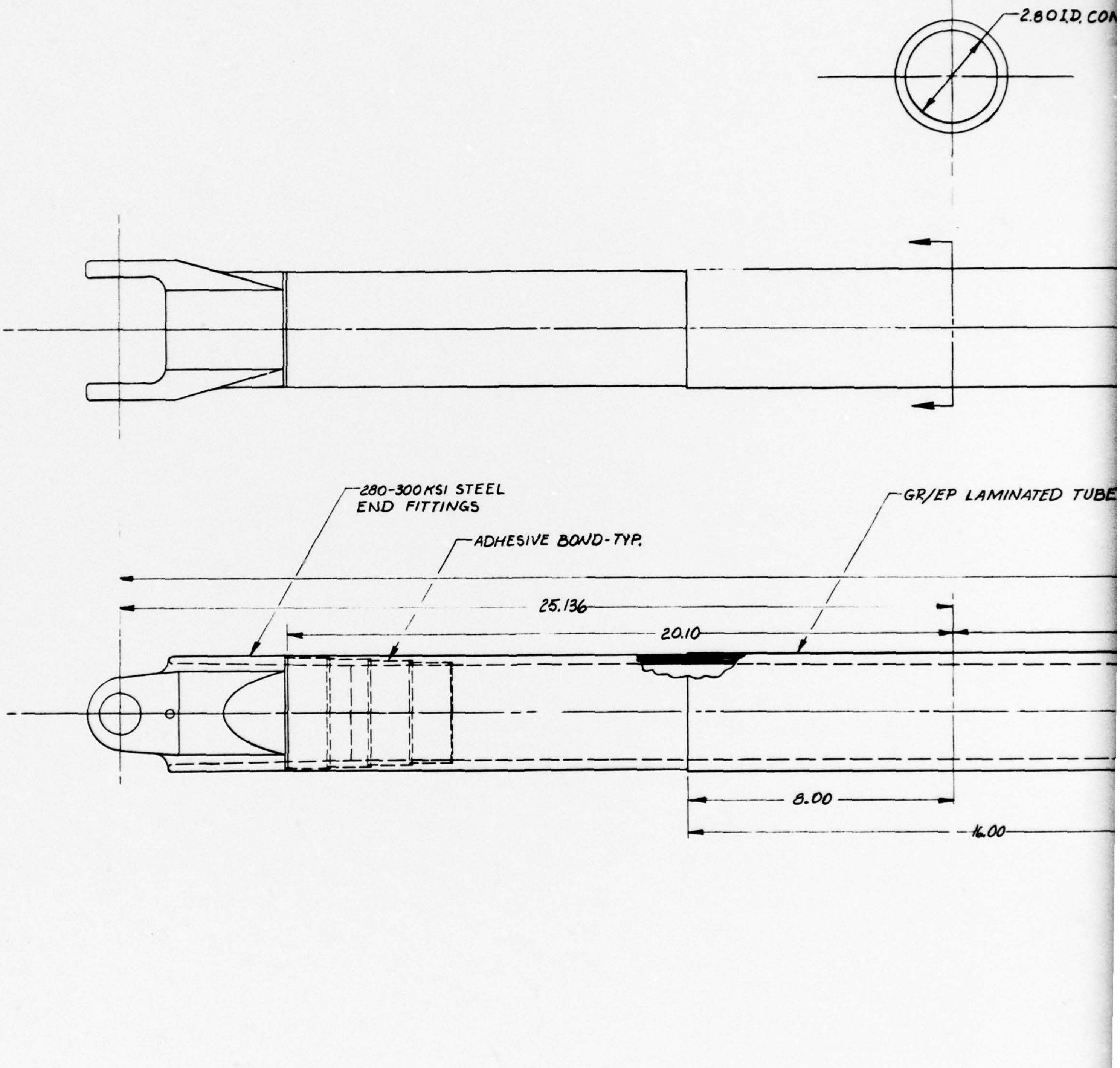


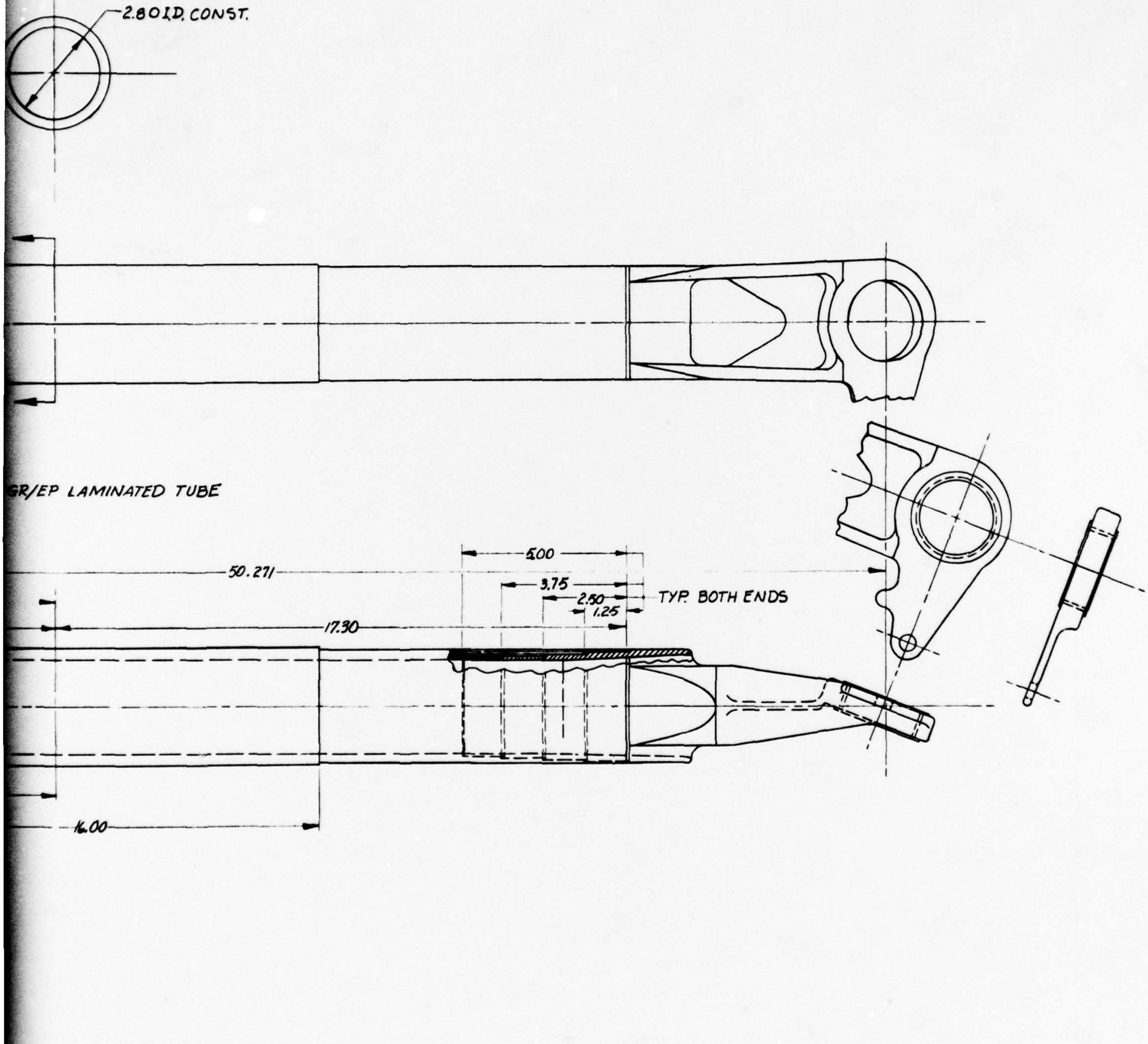
Figure 23. B-1 Nose Landing Gear Components

AD-A058 672 ROCKWELL INTERNATIONAL LOS ANGELES CALIF LOS ANGELE--ETC F/G 11/4
NEW CONCEPTS IN COMPOSITE MATERIAL LANDING GEAR FOR MILITARY AI--ETC(U)
FEB 78 V E WILSON F33615-76-C-3021
UNCLASSIFIED AFFDL-TR-78-2-VOL-2 NL

2 OF 3
AD
A058 672


1.0
2.8
2.5
3.2
2.2
3.6
4.0
2.0
1.1
1.8
1.25
1.4
1.6
MICROCOPY RESOLUTION TEST CHART


2.80 I.D. CON
280-300 KSI STEEL
END FITTINGS
ADHESIVE BOND-TYP.
GR/EP LAMINATED TUBE
25.136
20.10
8.00
16.00



2.80 I.D. CONST.
GR/EP LAMINATED TUBE
5.00
50.271
3.75
2.50
1.25
TYP. BOTH ENDS
17.30
16.00

7

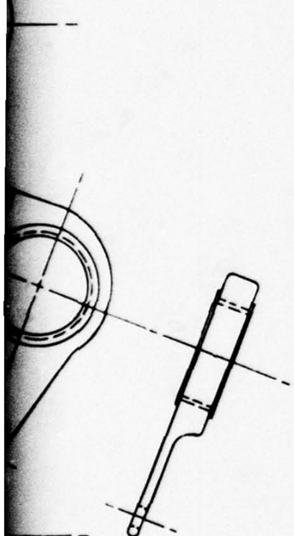


Figure 24.

SCALE: 1/2	DR. V.E. Wilson DATE 5-6-'76 MODEL	Los Angeles Aircraft Division Rockwell International INTERNATIONAL AIRPORT • LOS ANGELES, CALIFORNIA 90009	ADVANCED DESIGN
STUDY- COMPOSITE DRAG BRACE, FORWARD, B-1 NOSE GEAR - PHASE I, CONCEPT 1			D615-1-400

3

drilled for bearings. The forward end is pinned to the apex of the forward drag braces and the aft end is fastened to the strut.

The composite aft drag brace shown in figure 25 also uses the spliced metal/composite construction since steel end fittings are required to accommodate the high loads within the form constraint. The bearing end of these fittings is identical to the baseline part, but each fitting is only 10.25 inches long and terminates in a double multi-step lap joint for both caps and webs of the composite "I" section.

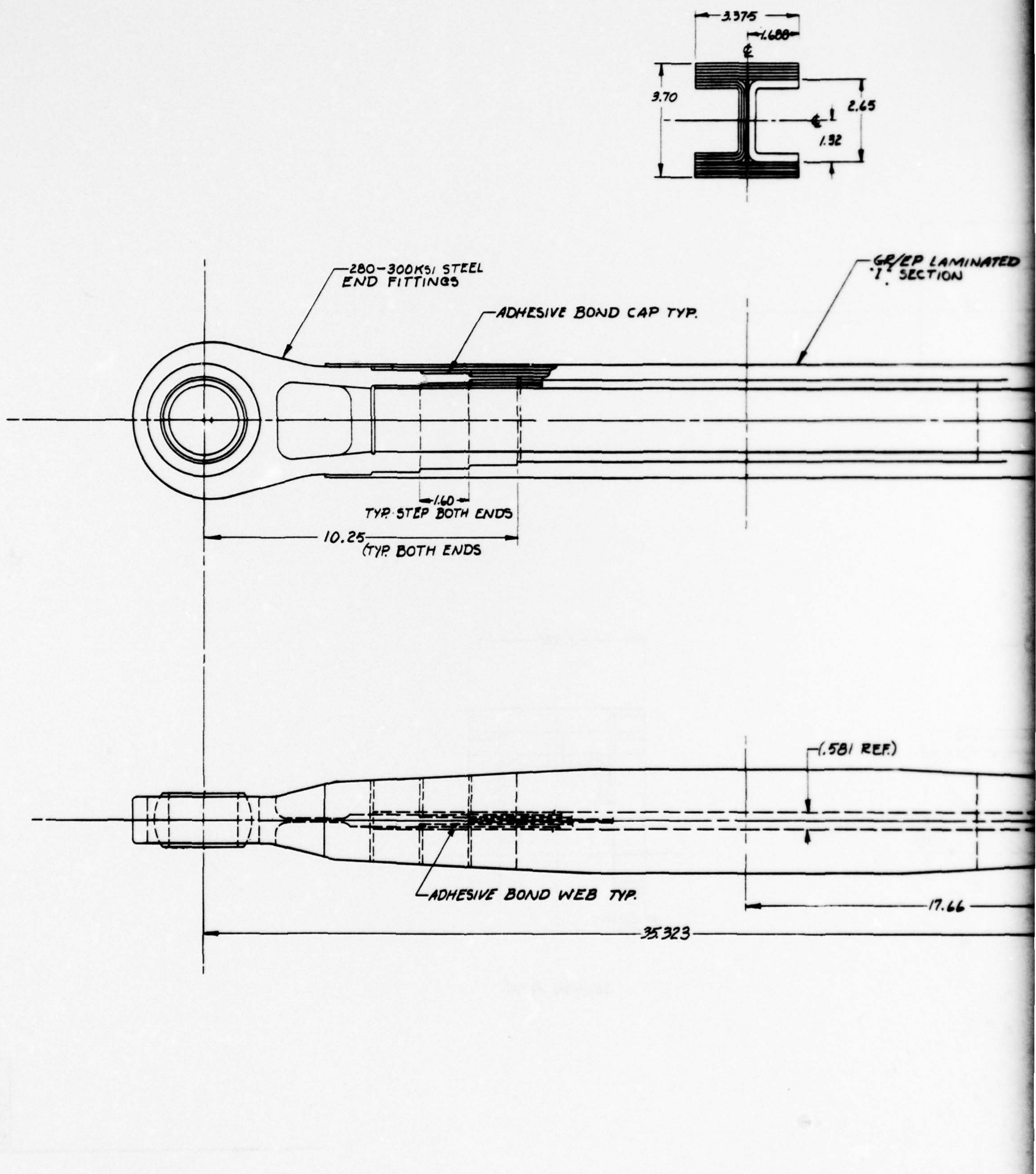
The graphite epoxy laminated "I" section is made up of back-to-back channel shaped laminates, using 50% $\pm$ 45° plies and 50% 0° (longitudinal) plies, with reinforced caps using more than 90% 0° plies and less than 10% $\pm$ 15° plies. This "I" section is 27.6 inches long and overlaps each end fitting 6.4 inches. The composite web is multi-step lap spliced to both sides of the web portion of the end fittings and the composite caps are multi-step lap spliced to both sides of both top and bottom cap sections of the end fittings to provide enough bond area to transfer the high axial loads. The entire assembly is then co-cured.

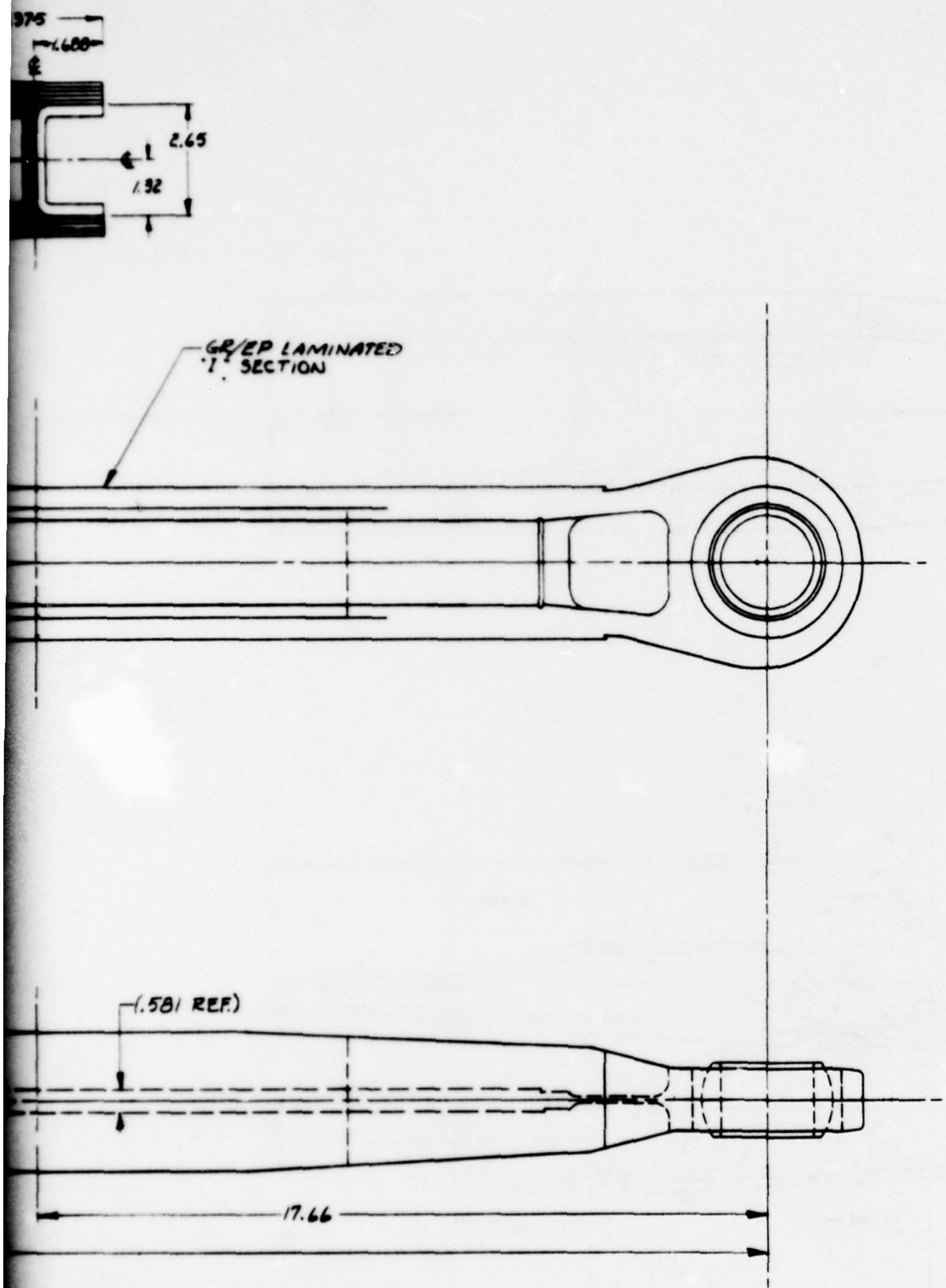
4.2.3 Forward Down Lock

The down lock struts, forward and aft, serve as a jury strut which holds the drag braces in the "on center" position when the gear is in the down position. The down lock struts connect the center joint of the drag braces to the fuselage structure, and are designed with an "over center" locking feature to assure that the drag braces will be supported. The loads in the down lock struts are axial and bending (a $\pm$ 11,000 pound design axial load with a transverse load applied to the aft end of the forward link acting upward of 559 pounds limit). The axial stiffness requirement for the lock links and backup structure "K" must be greater than 25,000 pound/inches.

The baseline B-1 forward down lock, figure 11, is a 7075 aluminum alloy forging. The forward portion of the part is an "I" section joined to a channel shaped aft section to straddle the aft down lock strut in the "over center" lock area.

The design concept shown in figure 26 is a graphite epoxy laminated inverted "U" shaped part using "race track" windings over laminated side walls and upper webs. The "race tracks" will be more than 90% 0° plies and the laminated webs will be 50% 0° plies and 50% $\pm$ 45° plies. This entire assembly will be co-cured.


3.375
1.688
3.70
2.65
1.32
280-300KSI STEEL END FITTINGS
ADHESIVE BOND CAP TYP.
GR/EP LAMINATED "I" SECTION
1.60
TYP. STEP BOTH ENDS
10.25 (TYP. BOTH ENDS
(.581 REF.)
ADHESIVE BOND WEB TYP.
17.66
35.323

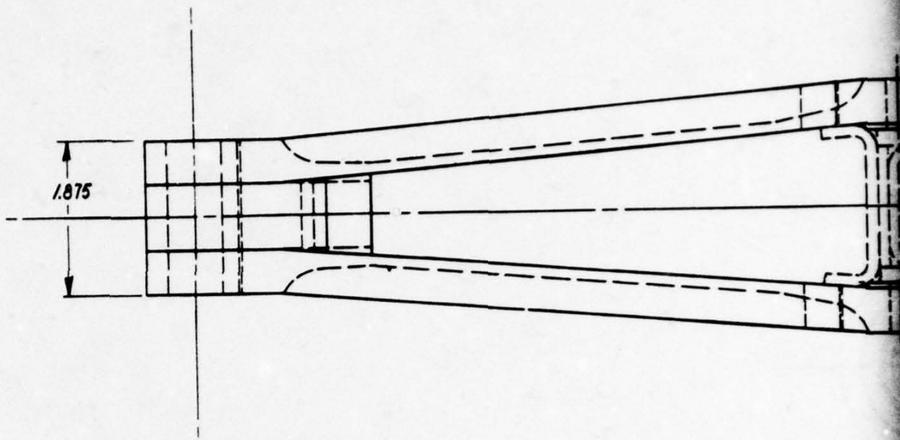


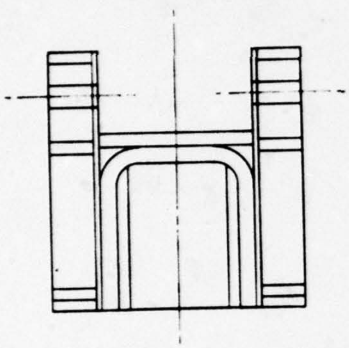
.975
1.600
2.65
1.32
GR/EP LAMINATED
"I" SECTION
(.581 REF.)
17.66

Figure 25.

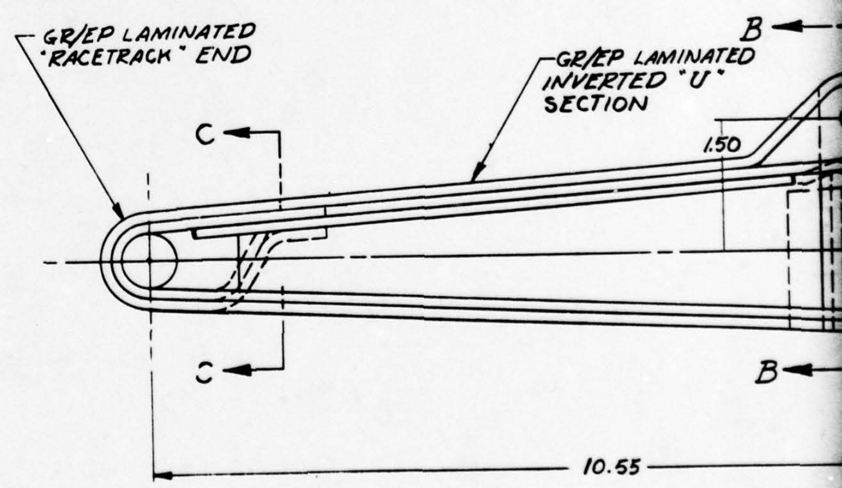
SCALE: 1/2	DR. V.E. WILSON DATE 5-12-76 MODEL	Los Angeles Aircraft Division Rockwell International INTERNATIONAL AIRPORT · LOS ANGELES, CALIFORNIA 90009	ADVANCED DESIGN
STUDY-COMPOSITE DRAG BRACE, AFT B-1 NOSE GEAR-PHASE I, CONCEPT 1			D615-1-401

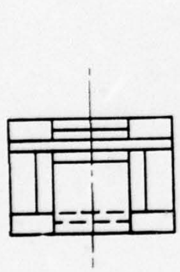
3



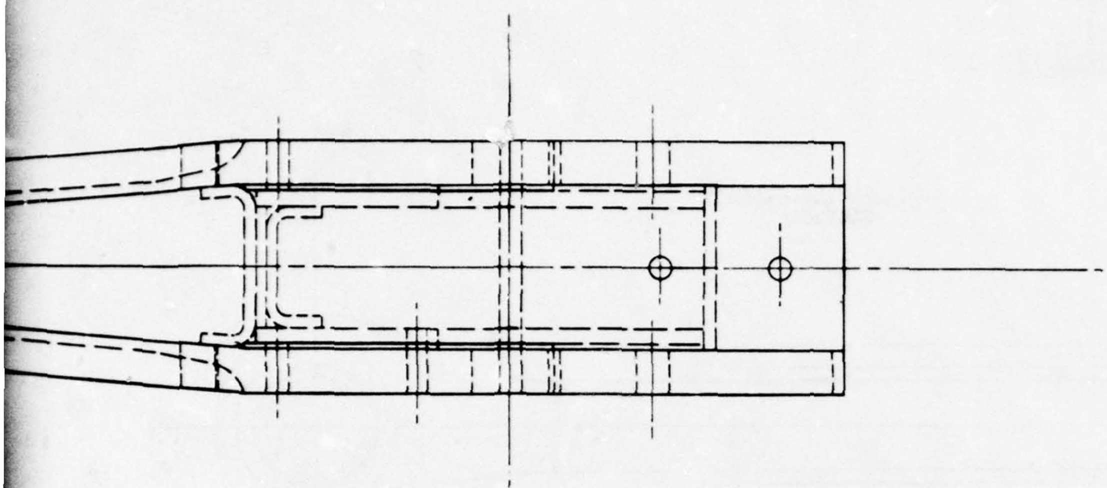


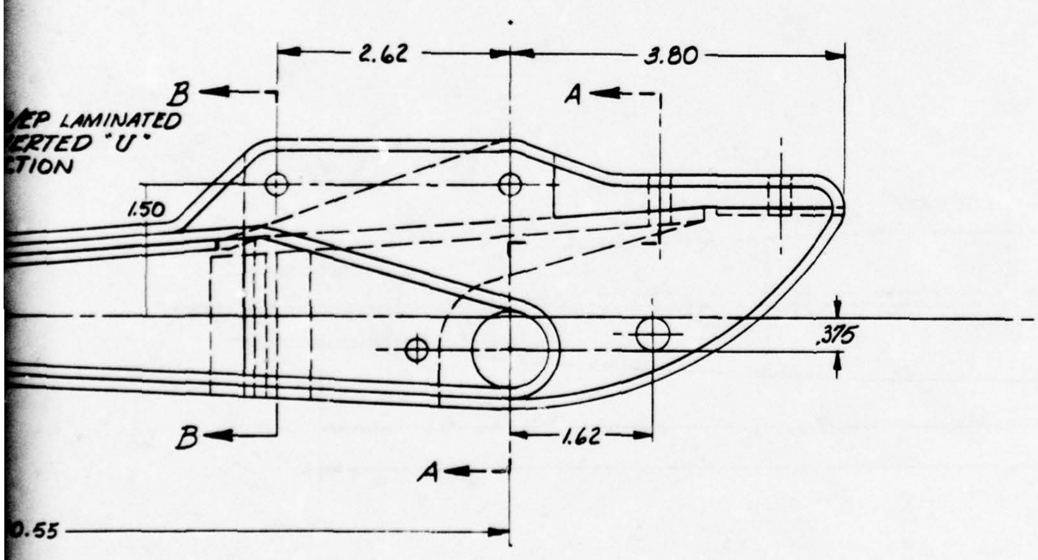
SECTION B-B

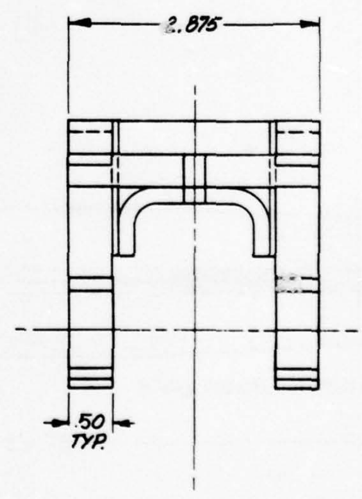




SECTION C-C




2.62
3.80
B
A
/EP LAMINATED
ERTED "U"
CTION
1.50
.375
B
1.62
A
0.55


2.875
.50
TYP.

SECTION A-A

7

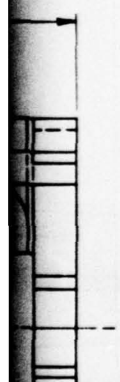


Figure 26.

SCALE: FULL	DR. V.E. Wilson DATE 5-21-76 MODEL	Los Angeles Aircraft Division Rockwell International INTERNATIONAL AIRPORT · LOS ANGELES, CALIFORNIA 90009	ADVANCED DESIGN
STUDY-COMPOSITE DOWN LOCK, FORWARD, B-1 NOSE GEAR-PHASE I, CONCEPT 1			D615-1-402

3

4.2.4 Aft Down Lock

The aft down lock connects the over center locking end of the forward down lock to the fuselage structure. The loads are as given in the Forward Down Lock section.

The baseline B-1 aft down lock, figure 11, is an "I" section 7075 aluminum alloy die forging. The forward section in the over-center lock area is a solid section and the aft end has a single lug for structural attachment, and dual lugs for attachment of the actuating cylinder.

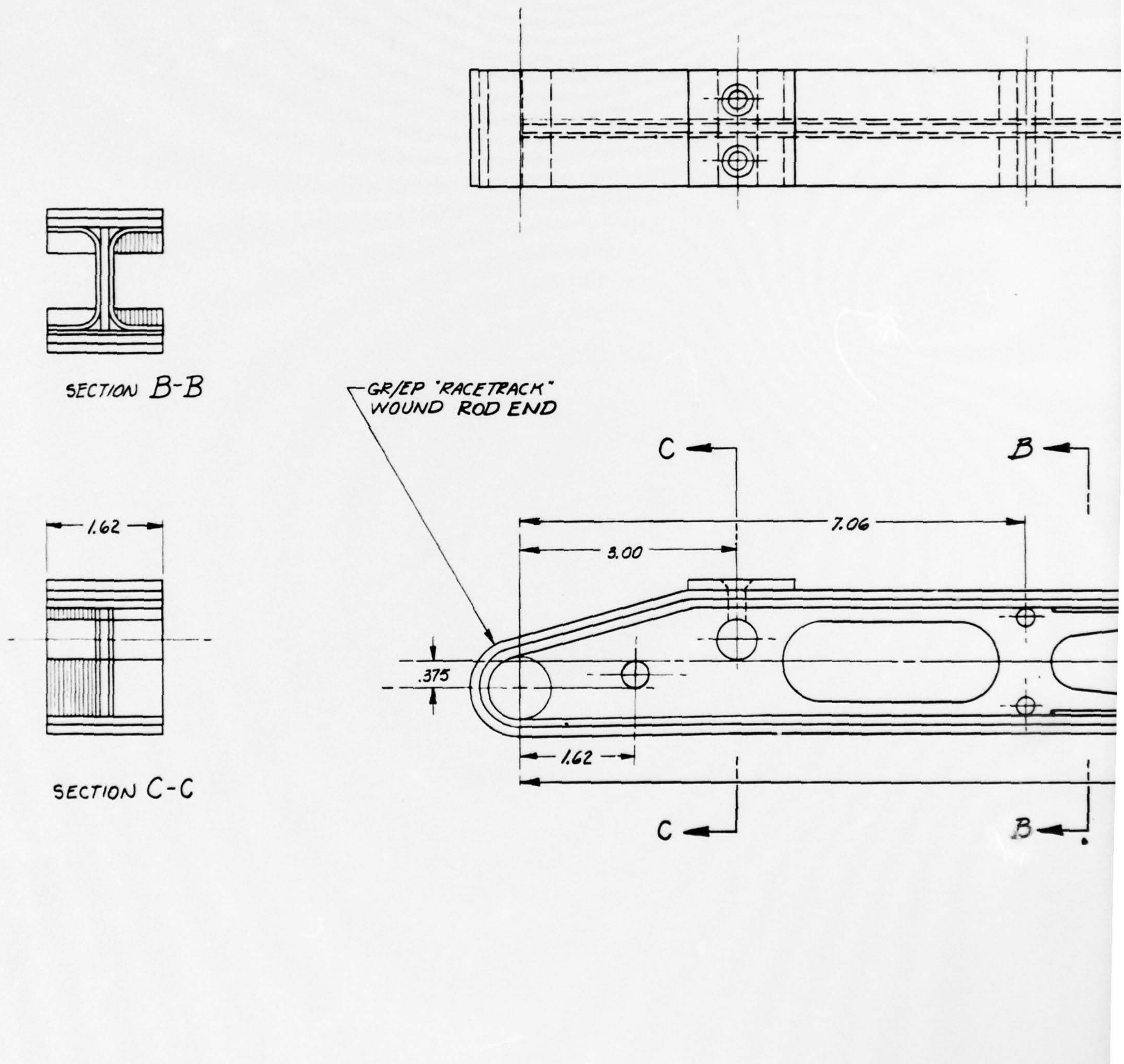
The composite aft down lock uses the spliced metal/composite construction which was employed on the drag braces. The aft end is aluminum and is identical to the end of the baseline aft down lock. This is necessary in order to react the high loads in the thin lug sections required to meet the form constraint and to assure interchangeability with the baseline components.

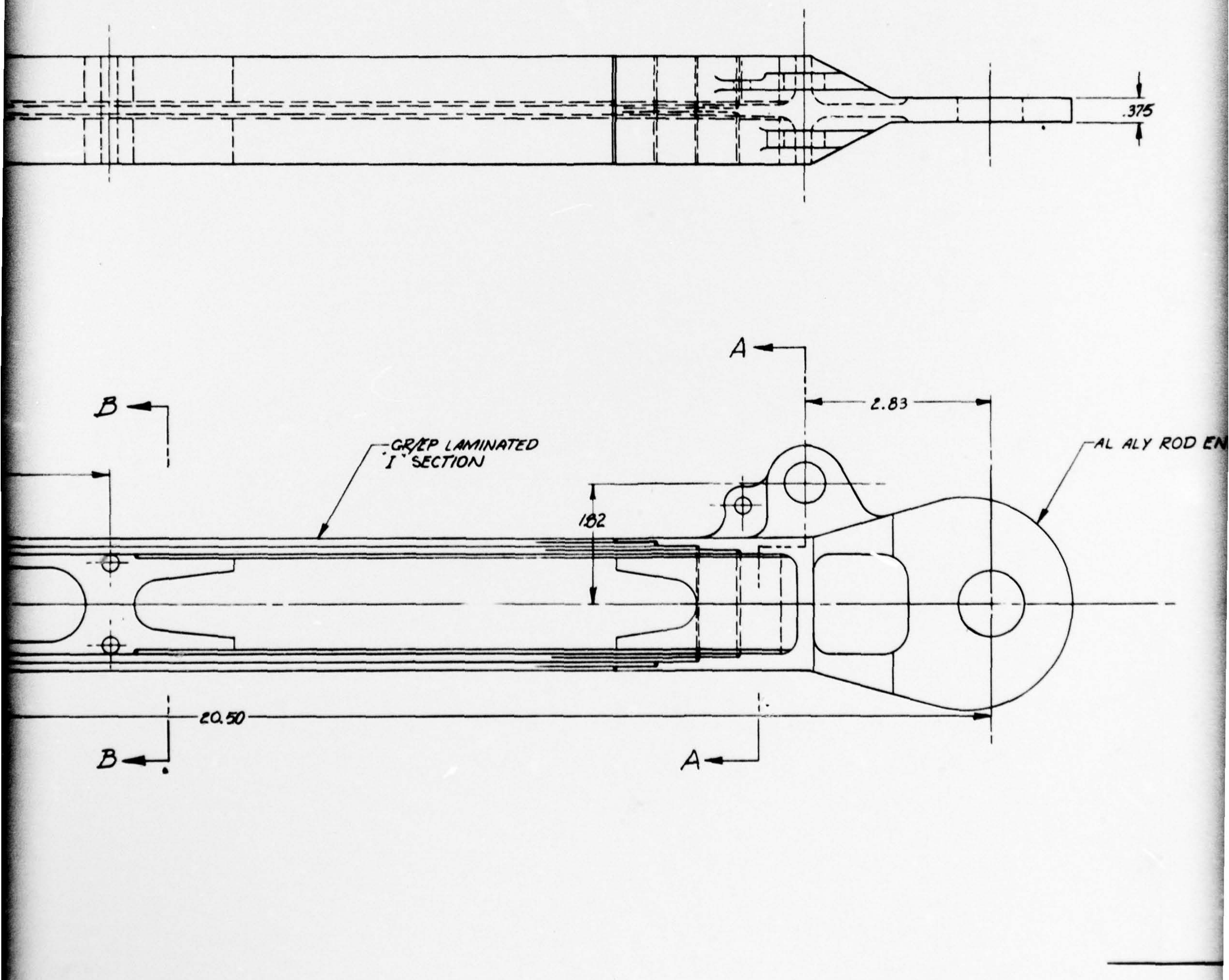
Figure 27 shows the composite design concept for the aft down lock. The aluminum actuator end is multi-step lap spliced to the graphite epoxy laminated "I" section. The "I" section consists of back-to-back channel shaped laminates using 50% $\pm$ 45° plies and 50% 0° (longitudinal) plies with "race track" wound caps using more than 90% 0° plies and less than 10% $\pm$ 15° plies. The composite section is 23.25 inches long with 2.75 inch splice overlaps. The composite web is multi-step spliced to both sides of the aluminum lug, and the composite caps are multi-step spliced to the inside surface of the aluminum caps from the lug. The caps are continued around (race track) the forward end of the lock link. The ends are reinforced using laminated fillets of 50% $\pm$ 45° and 50% 0° plies. The forward fillet will be 9 inches long to reinforce the over-center lock area. The entire assembly will be co-cured.

4.2.5 Torque Links

There are two torque links which are located on the aft side of the lower strut, see figure 23. They provide hinged links between the fixed outer strut and the rotating and translating inner piston/axle/wheel assembly. This allows steering and up and down motion of the nose wheel. The links are loaded by steering torque and the apex load on each link is $\pm$ 24,500 pounds (design).

Menasco Manufacturing Company will build the baseline torque links. They will be aluminum forgings, triangular shaped, fastened together at the apex and mounted to the strut and the piston at the base, see figure 13.


SECTION B-B
1.62
SECTION C-C
GR/EP "RACETRACK"
WOUND ROD END
C
C
B
B
7.06
3.00
.375
1.62



7

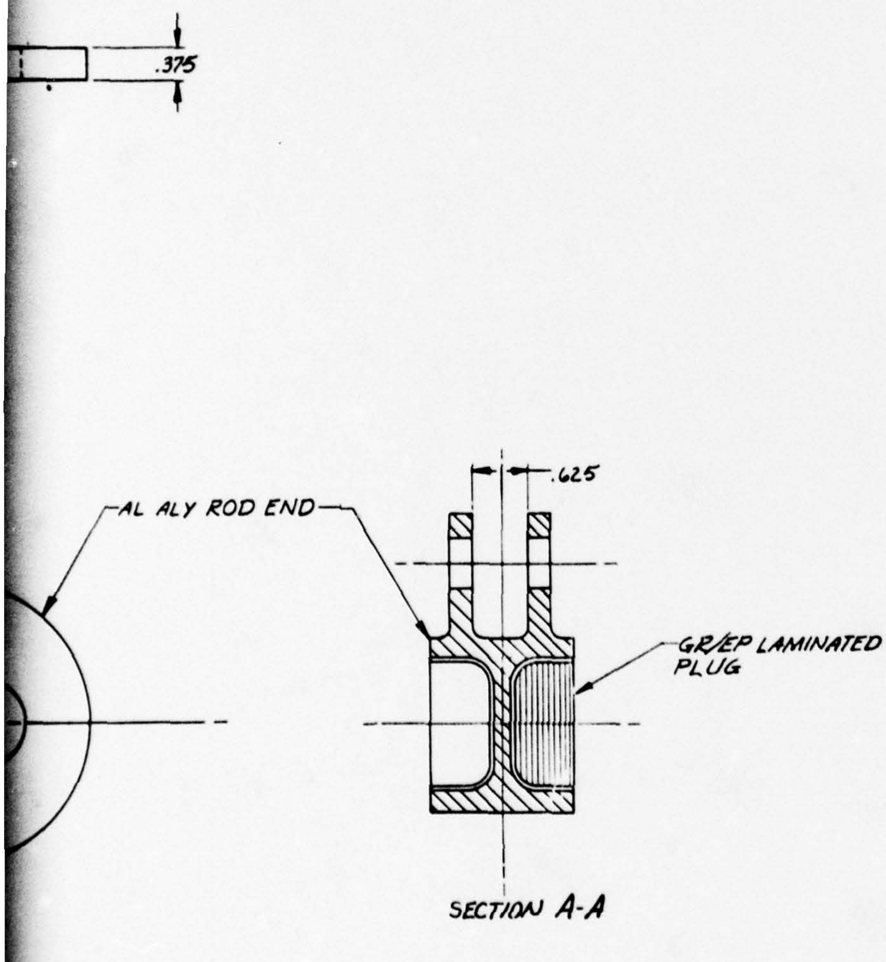


Figure 27.

SCALE FULL	DR. K.E. Wilson DATE 5-26-76 MODEL	Los Angeles Aircraft Division Rockwell International INTERNATIONAL AIRPORT · LOS ANGELES, CALIFORNIA 90009	ADVANCED DESIGN
STUDY-COMPOSITE DOWN LOCK, AFT B-1 NOSE GEAR-PHASE I, CONCEPT 1			D615-1-403

3

The design concept shown in figure 28 is a graphite epoxy laminated part using "race track" wound laminations. The outer race track laminate will be more than 80% 0° (base to apex) plies with less than 20% $\pm$ 45° plies. The inner race track laminate will be 60% 0° plies and 40% $\pm$ 45° plies. The laminated inner block will be 50% 0° plies and 50% $\pm$ 45° plies. The assembly will be co-cured.

4.2.6 Strut and Trunnion Arms

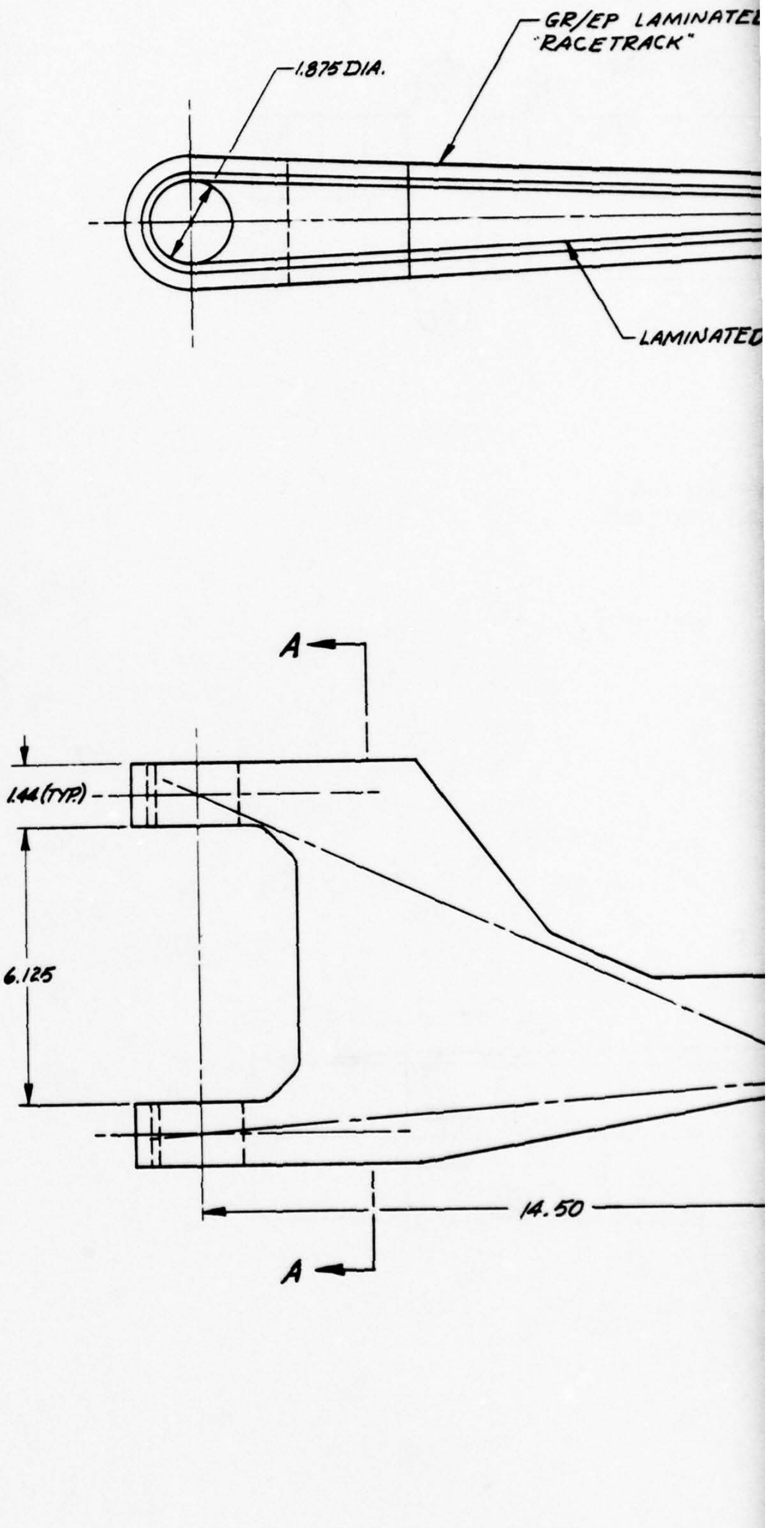
The strut is the structural component which fastens to the trunnion fittings on the fuselage structure, it contains the shock absorbing system and supports the piston/axle/wheel assembly. It provides for attachment of major components such as the actuating cylinders, the drag braces, the up lock, the steering system, the torque links and the piston/axle/wheel assembly. The loads are given in figure 19 and 20.

Menasco will build the baseline strut using a machined aluminum alloy forging. This one piece part will include the cylindrical strut, the trunnion arms and the actuation cylinder attachment horns, see figures 15 and 16.

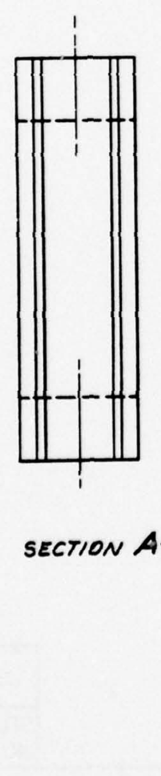
Two design studies were made of the strut and trunnion arms. Both studies use an aluminum strut section to assure that the attachment for major components, listed in the first paragraph above, will meet the form constraint and fit the metallic mating parts.

Study A, figure 29, features a graphite epoxy composite one piece section which incorporates both actuator horns, trunnion arms and a center cylindrical tube which is mechanically fastened to the aluminum center strut. Both the actuator horns and the trunnion arms use race track wound cap sections using at least 90% 0° and less than 10% $\pm$ 45° plies. The webs will be 50% $\pm$ 45°, 25% 0° and 25% 90° plies. The caps will be multi-step lap spliced to the horn and trunnion race track wound plies, and to the laminations forming the tube around the strut. Additional 0° race track plies will be wound around the top and bottom of the tubular section to tie the trunnion arms to the strut. The entire composite subassembly will be co-cured.

Study B, figure 30, shows an aluminum strut, similar to the baseline except for two additional sets of lugs which pick up the composite trunnion arms. The apex of the trunnion arms are fastened to the actuator horn/trunnion arm end fitting. The strut is then assembled using mechanical fasteners. The composite trunnion arms are a triangular box section with beams to the apex and upper and lower webs connected by channel sections at the base leg and across the center.



GR/EP LAMINATED
"RACETRACK"
1.875 DIA.
LAMINATED
A
1.44 (TYP.)
6.125
14.50
A



SECTION A-A

1

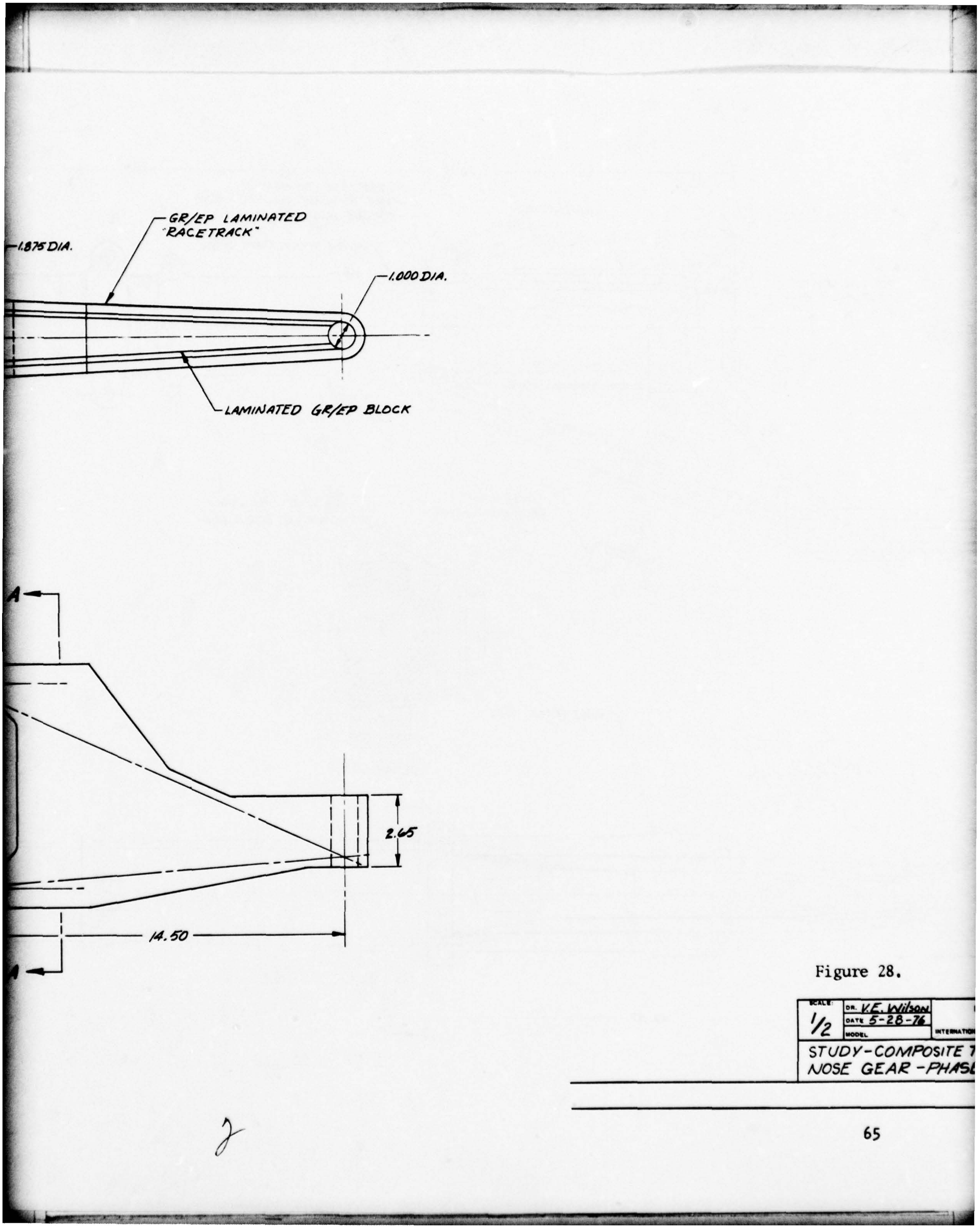
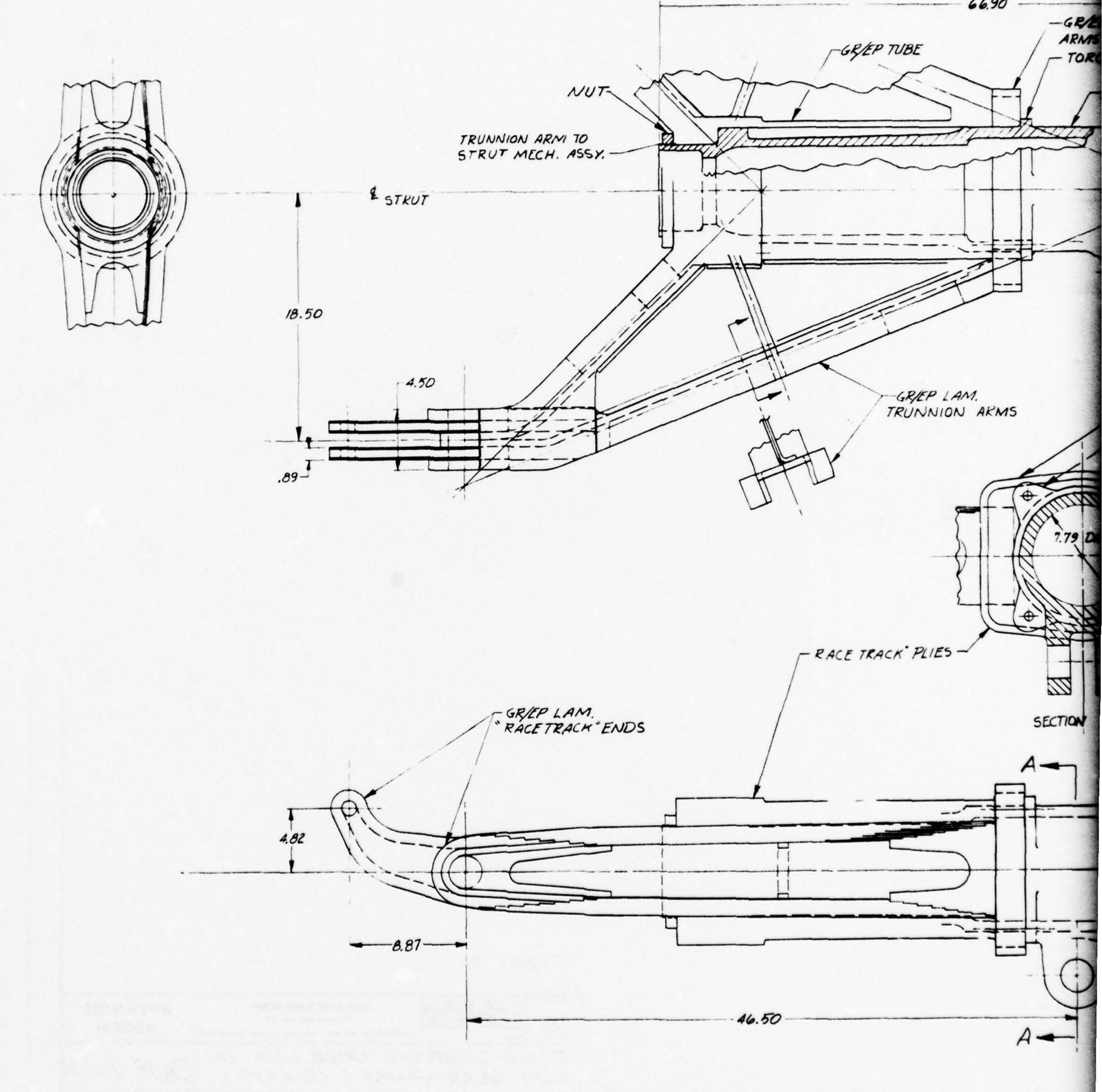

GR/EP LAMINATED "RACETRACK"
1.875 DIA.
1.000 DIA.
LAMINATED GR/EP BLOCK
A
2.65
14.50
A
SCALE: 1/2
DR. V.E. Wilson
DATE 5-28-76
MODEL
INTERNATION
STUDY-COMPOSITE T
NOSE GEAR -PHASE

Figure 28.

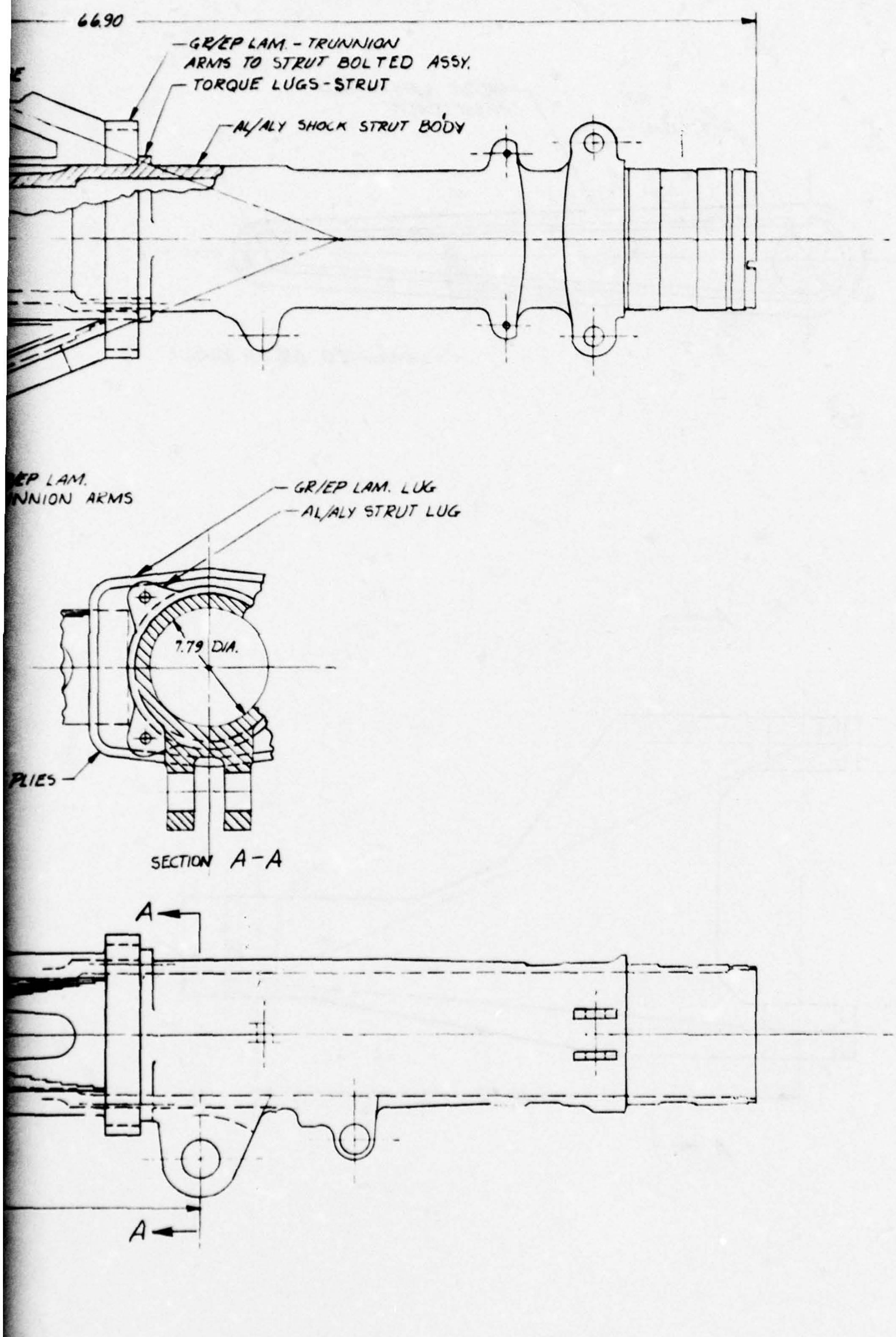
Figure 28.

SCALE: 1/2	DR. V.E. Wilson DATE 5-28-76 MODEL	Los Angeles Aircraft Division Rockwell International INTERNATIONAL AIRPORT · LOS ANGELES, CALIFORNIA 90009	ADVANCED DESIGN
STUDY-COMPOSITE TORQUE LINK, B-1 NOSE GEAR-PHASE I, CONCEPT 1			D615-1-404

3


66.90
GR/EP TUBE
NUT
TRUNNION ARM TO STRUT MECH. ASSY.
℄ STRUT
18.50
4.50
.89
GR/EP LAM. TRUNNION ARMS
7.79 D
"RACE TRACK" PLIES
SECTION
GR/EP LAM. "RACETRACK" ENDS
A
4.82
8.87
46.50
A

1

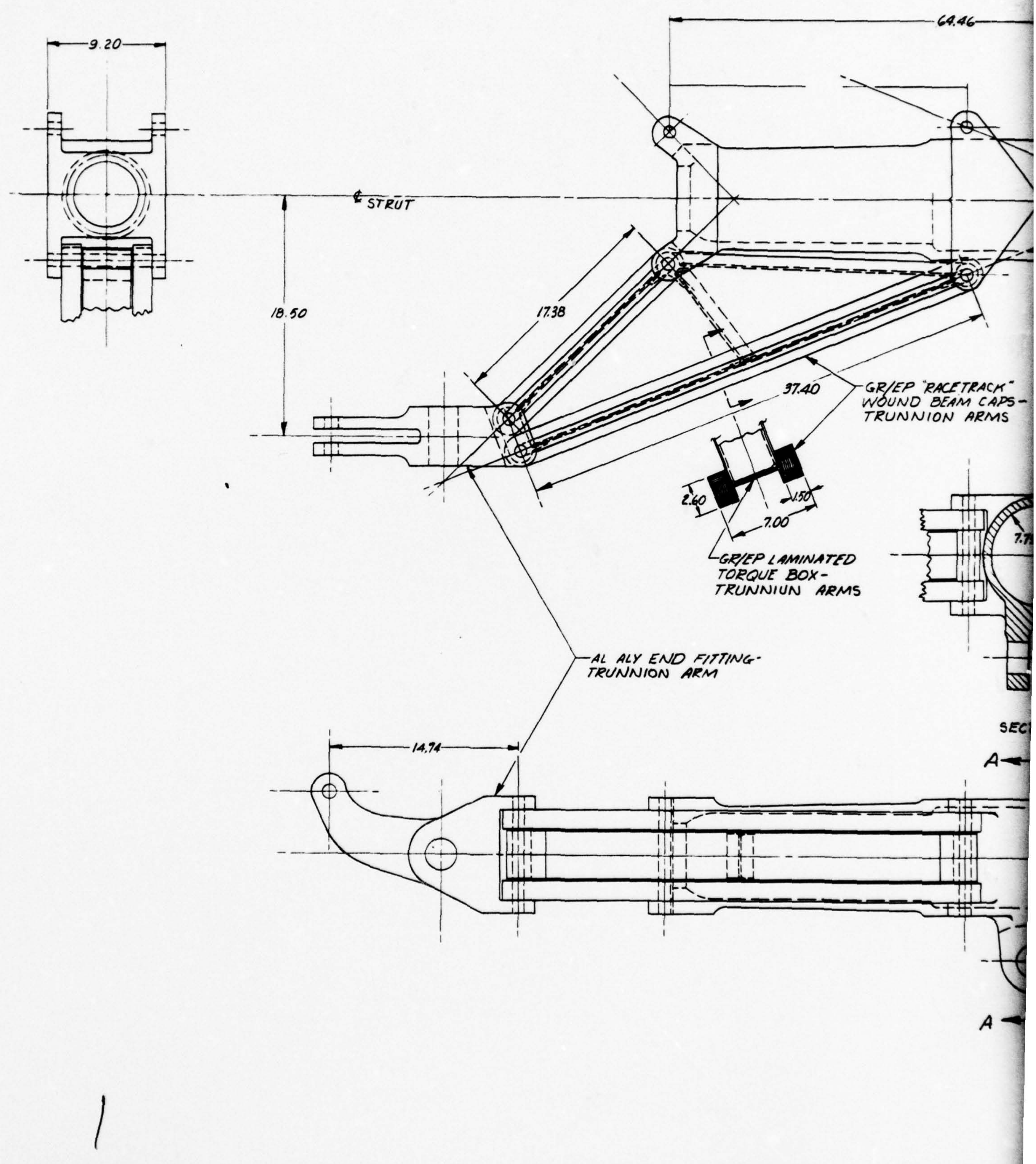


66.90
GR/EP LAM. - TRUNNION ARMS TO STRUT BOLTED ASSY.
TORQUE LUGS-STRUT
AL/ALY SHOCK STRUT BODY
EP LAM.
NNION ARMS
GR/EP LAM. LUG
AL/ALY STRUT LUG
7.79 DIA.
PLIES
SECTION A-A
A
A

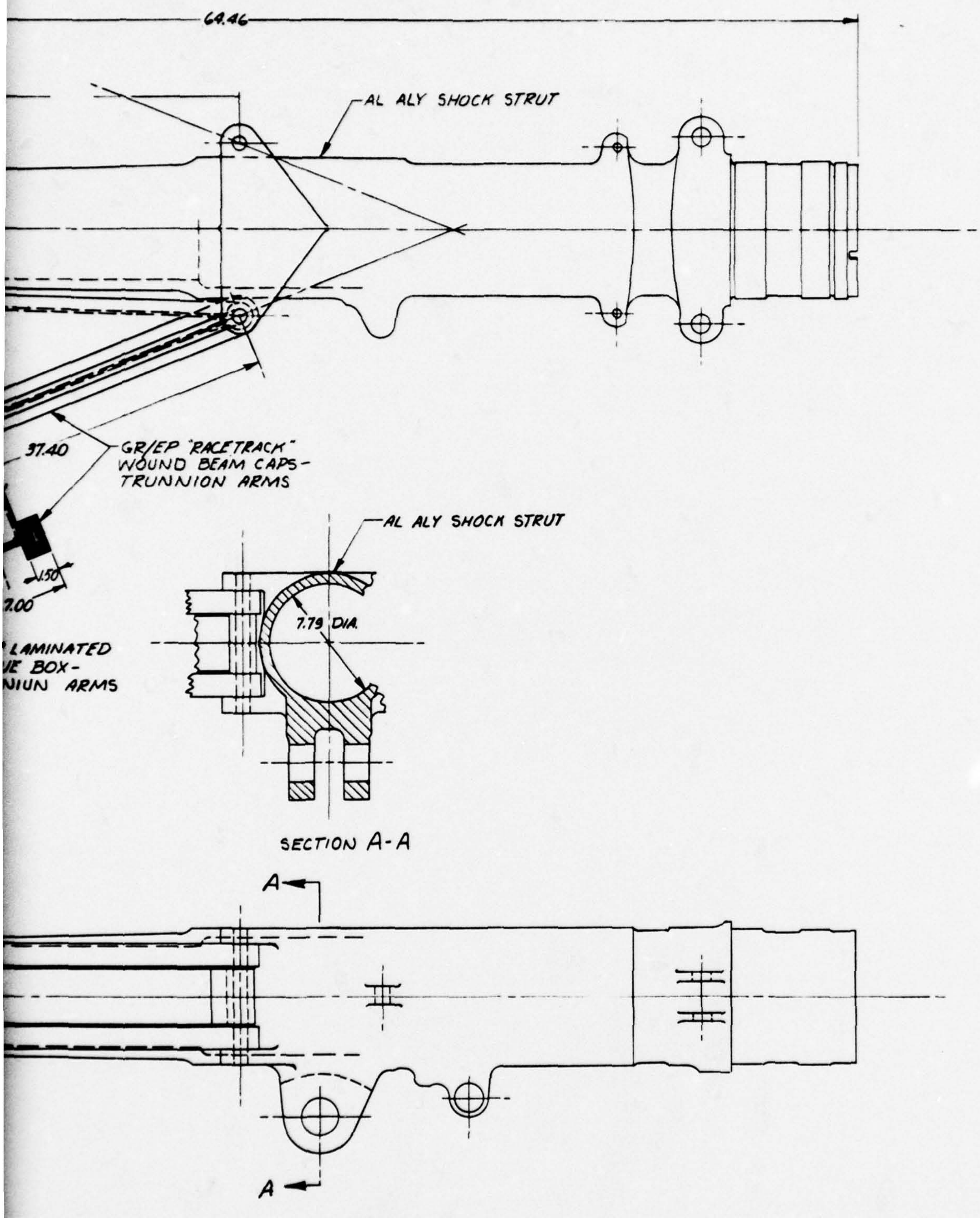
Figure 29

SCALE			
.23	DR. V.E Wilson DATE 6-15-76 MODEL	Los Angeles Aircraft Division Rockwell International INTERNATIONAL AIRPORT - LOS ANGELES, CALIFORNIA 90009	**ADVANCED DESIGN**
STUDY-A-COMPOSITE TRUNNION ARMS & AL ALY STRUT - B-1 NOSE GR - PHASE I, CONCEPT 1			D615-1-411

5



9.20
℄ STRUT
64.46
18.50
17.38
37.40
GR/EP "RACETRACK" WOUND BEAM CAPS-TRUNNION ARMS
2.60
1.50
7.00
GR/EP LAMINATED TORQUE BOX-TRUNNIUN ARMS
AL ALY END FITTING-TRUNNION ARM
14.74
SECT
A
A



64.46
AL ALY SHOCK STRUT
37.40
GR/EP "RACETRACK" WOUND BEAM CAPS-TRUNNION ARMS
1.50
2.00
LAMINATED
UE BOX-
NIUN ARMS
AL ALY SHOCK STRUT
7.79 DIA.
SECTION A-A
A
A

7

Figure 30.

SCALE: .23	DR. V.E. Wilson DATE 6-29-76 MODEL	Los Angeles Aircraft Division Rockwell International INTERNATIONAL AIRPORT · LOS ANGELES, CALIFORNIA 90009	ADVANCED DESIGN
STUDY-B-COMPOSITE TRUNNION ARMS & AL ALY STRUT-B-1 NOSE GR.-PHASE I, CONCEPT 1			D615-1-405

3

The two beams are "I" sections with caps which consist of a "race track" wound around a solid laminated center section, and channel section webs. The cap "race track" and center section laminate will be at least 90% 0° plies with less than 10% ± 15° plies. The channel section beam webs and the top and bottom box webs will be 50% ± 45°, 25% 0° and 25% 90° plies. The beam end corners of the box section are composite spools with flanges to pick up the webs. They will be "race track" wound around the fastener hole using 50% ± 45°, 25% 0° and 25% 90° plies.

"Race track" beam caps together with corner spools, the top and bottom box webs, the long beam channel web and the center stiffener channel web will be co-cured. In a secondary operation, the channel webs on the base and short side will be bonded to close out the trunnion arm box assembly.

4.2.7 Wheels

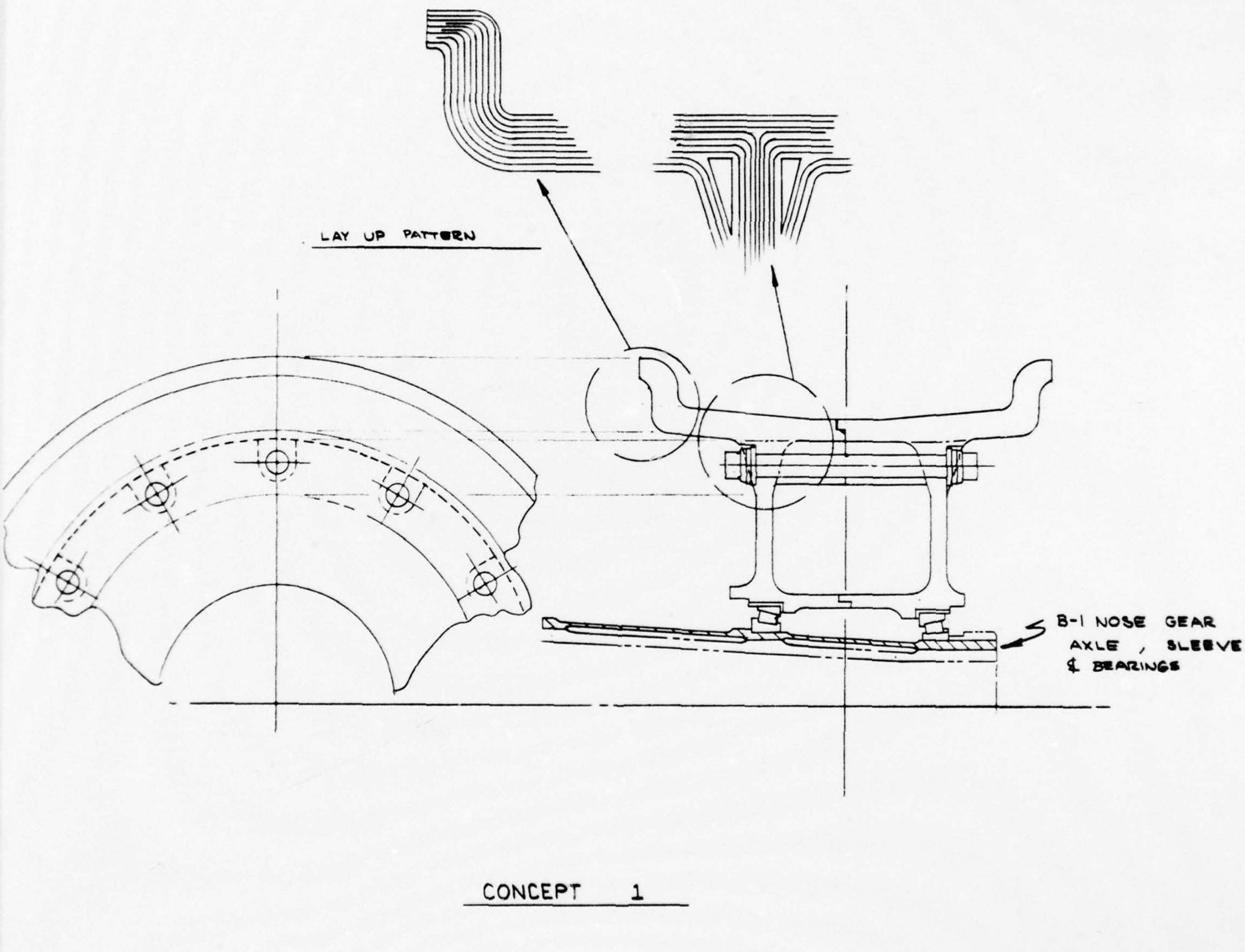
The B-1 baseline nose landing gear has dual wheels, see figure 23. Each wheel consists of an inboard and an outboard wheel half which are bolted together. These half wheels are dish shaped aluminum alloy forgings, see figure 17. Goodyear Aerospace will build the wheels. The loads on the wheels are given in figure 22.

The composite wheel, shown in figure 31, is made up of two laminated graphite epoxy wheel halves which are bolted together to form a complete wheel. The wheel halves will be laid up with plies, as shown in figure 31 Both 0° (radial), and ± 45° plies will be continuous from hub to rim, and 90° (hoop) plies will be continuous around both hub and rim areas. Machined ring shaped inserts are used in both hub and rim "Tee" areas, as shown in figure 31. The inserts will be precured before machining to size and used in the wheel layup. This assembly will then be co-cured.

4.3 CONCEPT 2 - MODIFIED

This study was made to determine what additional usage of composites could be gained by removing the "form" constraint which limited Concept 1 designs. The Concept 2 designs are constrained by the existing attachment, stowage and functional requirements ("fit and function") of the baseline B-1 metallic nose gear. The existing location of the strut trunnions, the drag brace structure mounts, the gear retract cylinder mounts and the up lock hook mounts were retained. The size of the baseline nose gear wheel well and stowage clearances were also retained.

Study showed that the wheel well width constraint required that the piston and the lower strut (cylinder) remain metallic to avoid a larger



CONCEPT 1

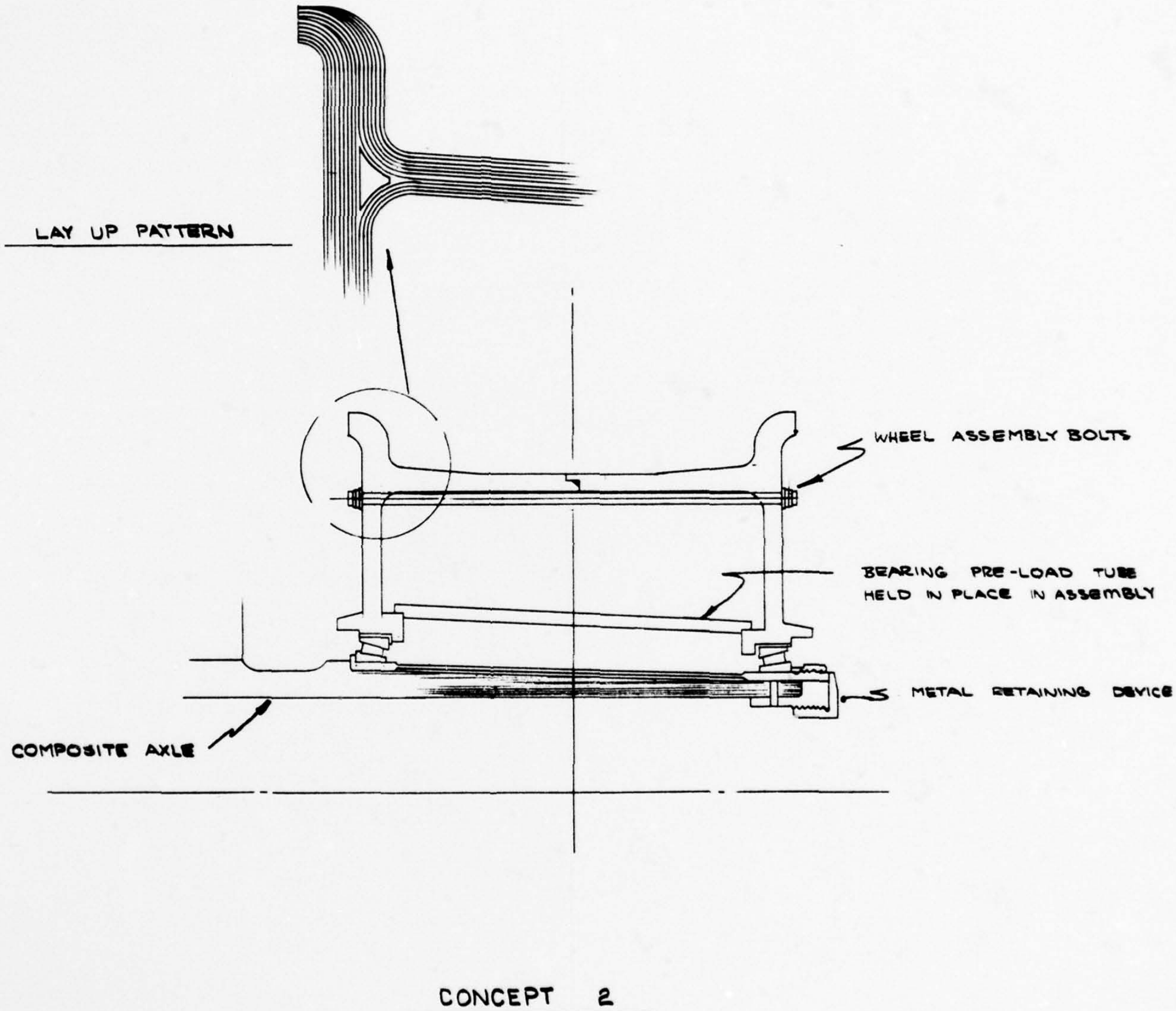
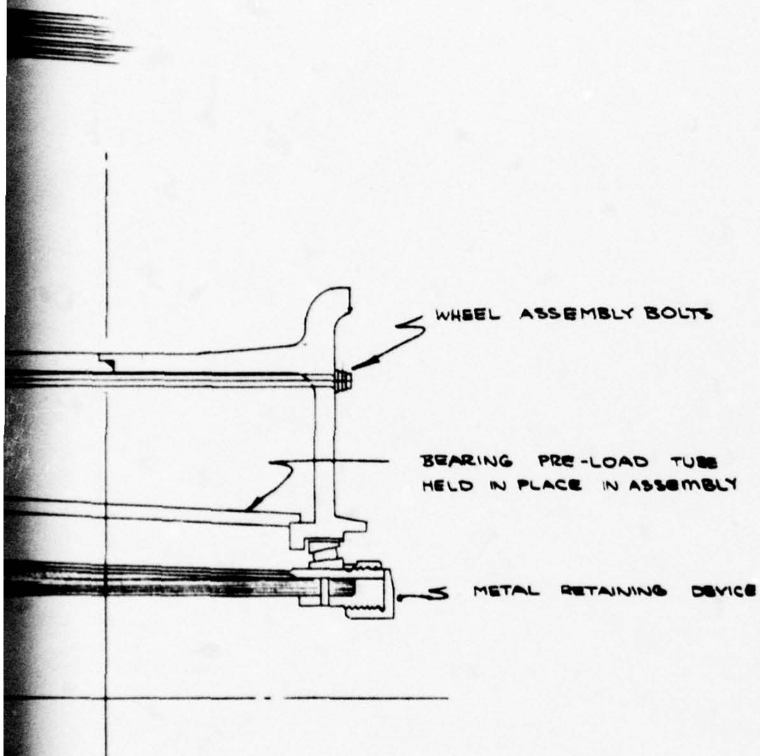


Figure 31.

SCALE:	DR. F. ATH
1/2	DATE JUNE
	MODEL
STUDY - CON	
NOSE GEAR	

2



CEPT 2

Figure 31.

SCALE: 1/2	DR. F. ATKINS DATE JUNE 8,'76 MODEL	Los Angeles Aircraft Division Rockwell International INTERNATIONAL AIRPORT · LOS ANGELES, CALIFORNIA 90009	ADVANCED DESIGN
STUDY - COMPOSITE WHEELS, B-1 NOSE GEAR, PHASE I, CONCEPT 1 & 2			D615-1-406

3

diameter composite cylinder which would force the nose wheels apart and create interference with the nose gear well side walls. Two studies have been made of drag braces, down lock links, torque arms, strut and wheels to improve the usage of composites by altering the "form" of the parts.

4.3.1 Concept 2 - Study A

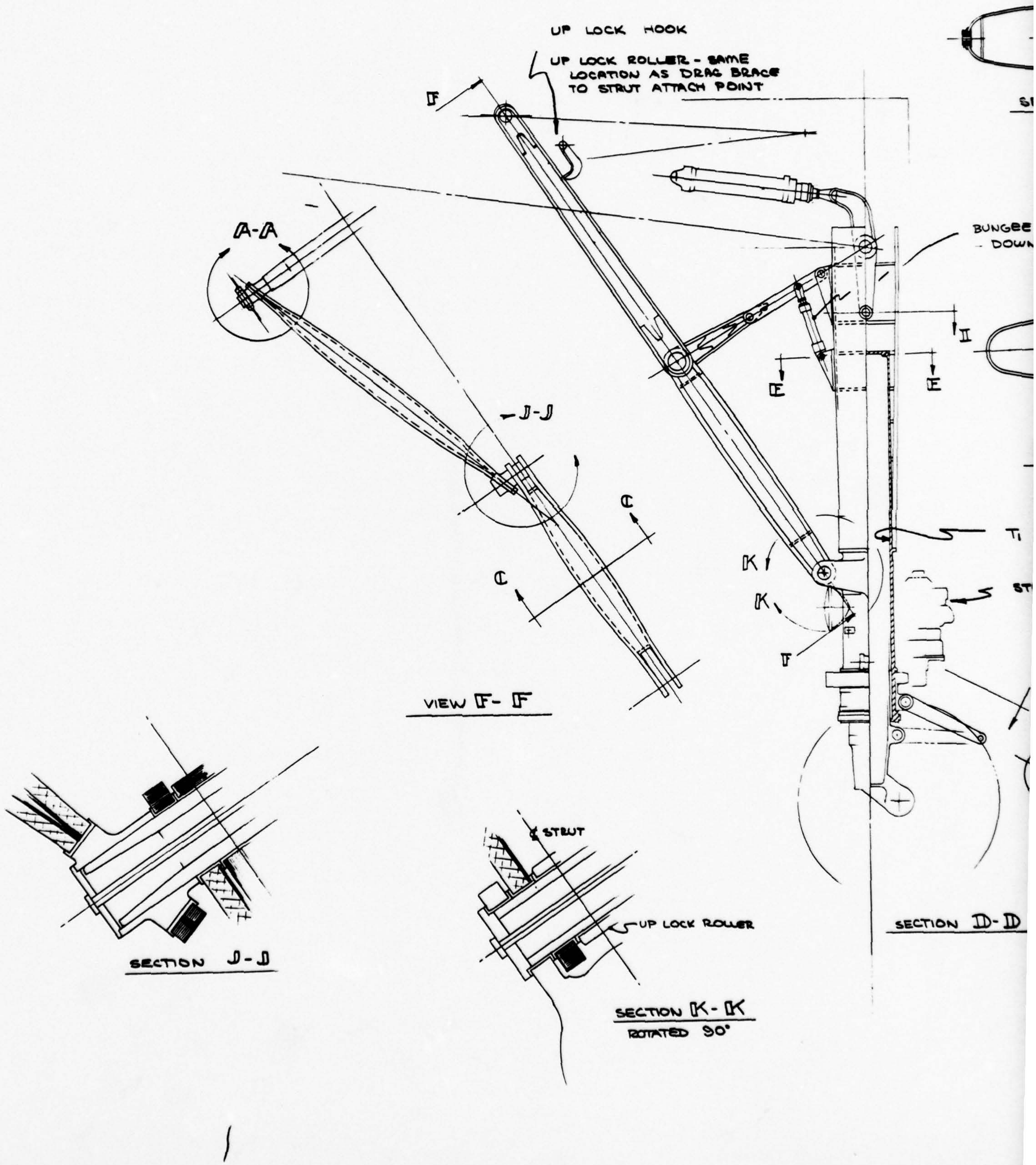
This nose gear concept works as described in the "baseline section, except that the kinematics of the drag braces and the lock links have been revised, see figure 32. The drag brace lower attachment was moved down the strut to the location of the "up lock" pin. This kept all the highly loaded lugs on the lower, metallic section of the strut. The upper mount for the down lock links was moved to allow a change in configuration of the upper strut.

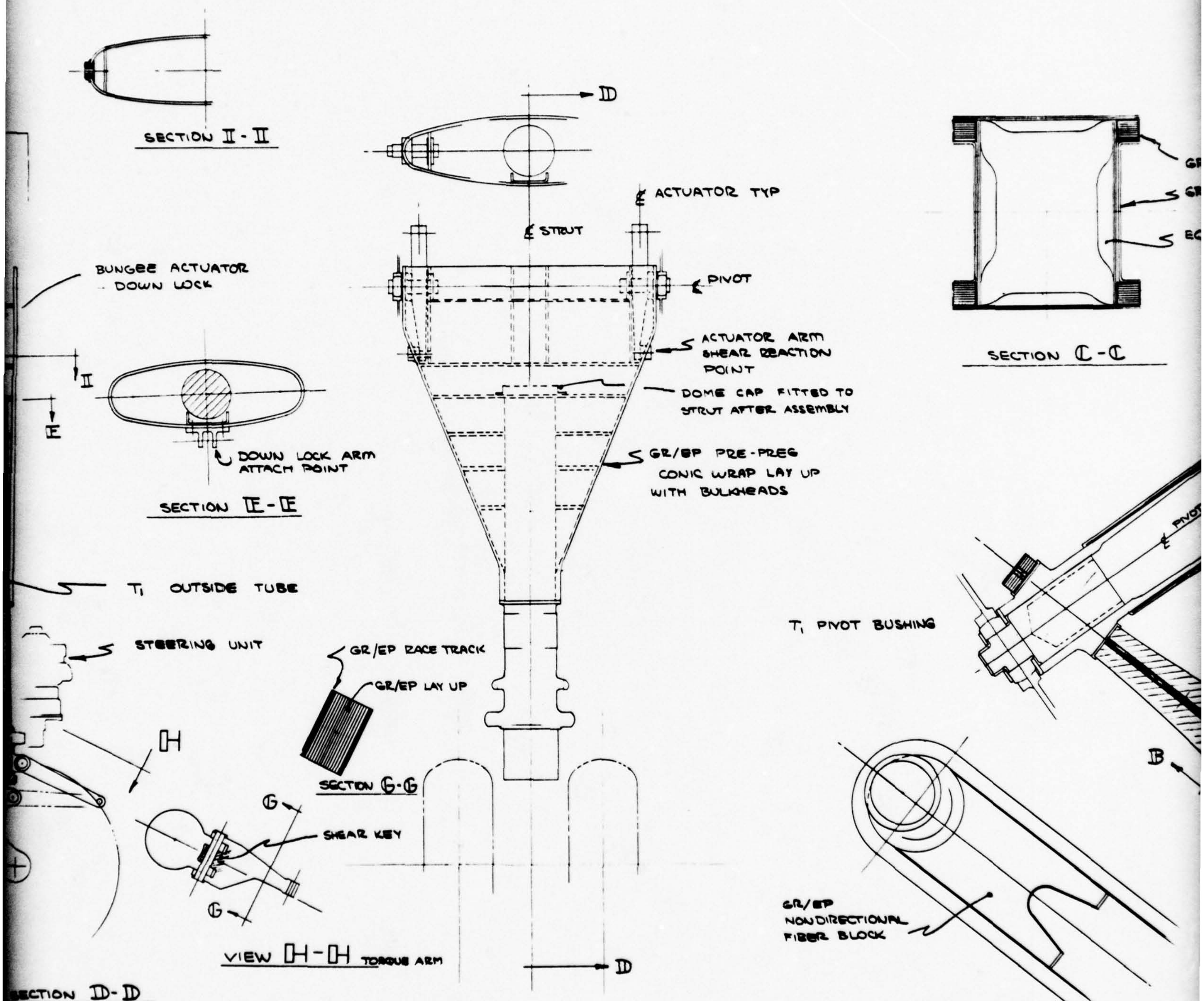
The drag braces are all composite in this concept since the configuration of the ends have been revised. The drag brace mounting pins and fittings have been enlarged to accept the required larger size of the composite drag brace end configurations. Both forward and aft drag braces now feature a dual "race track" configuration in which the race track caps are positioned on each corner of a rectangular box section. This allows the size of the box section, and therefore the cap locations, to vary according to the section property needs of the part. At the midpoint of the long axially loaded member, the box section is square so that the cap locations produce equal section properties in both the X-X and Y-Y directions. The box section sidewalls are stiffened by beading the inner ply of the laminated web and bonding it to the flat webs.

The configuration of the down lock links have been revised to improve the joint design and the usage of composites. The forward (lower) down lock is a one piece link which fastens to the drag brace apex pin between the lugs of the aft drag brace. This avoids the necessity of a separate down lock lug on the drag brace, which is difficult to fabricate using composites. The upper end of the forward down lock is extended beyond the pivot pin to act as an over-center latch.

The aft (upper) down lock is a dual link configuration which provides for both the forward down lock link and the actuator/bungee to mount between the links. A pin between the links acts with the extended forward link to provide the over-center latch feature. Both the single forward and the dual aft links will use the "race track" design concept.

Torque link mounting lugs on both the strut (cylinder) and piston have been revised to allow a change in torque link design. A center shear lug


UP LOCK HOOK
UP LOCK ROLLER - SAME LOCATION AS DRAG BRACE TO STRUT ATTACH POINT
A-A
J-J
C
K
F
E
BUNGEE
VIEW F-F
SECTION J-J
℄ STRUT
UP LOCK ROLLER
SECTION K-K
ROTATED 90°
SECTION D-D


SECTION II - II
D
ACTUATOR TYP
STRUT
PIVOT
BUNGEE ACTUATOR
DOWN LOCK
ACTUATOR ARM
SHEAR REACTION
POINT
DOME CAP FITTED TO
STRUT AFTER ASSEMBLY
DOWN LOCK ARM
ATTACH POINT
SECTION E - E
GR/EP PRE-PREG
CONIC WRAP LAY UP
WITH BULKHEADS
SECTION C - C
T₁ OUTSIDE TUBE
T₁ PIVOT BUSHING
STEERING UNIT
GR/EP RACE TRACK
GR/EP LAY UP
H
SECTION G-G
G
SHEAR KEY
B
GR/EP
NONDIRECTIONAL
FIBER BLOCK
VIEW H-H TORQUE ARM
SECTION D-D

2

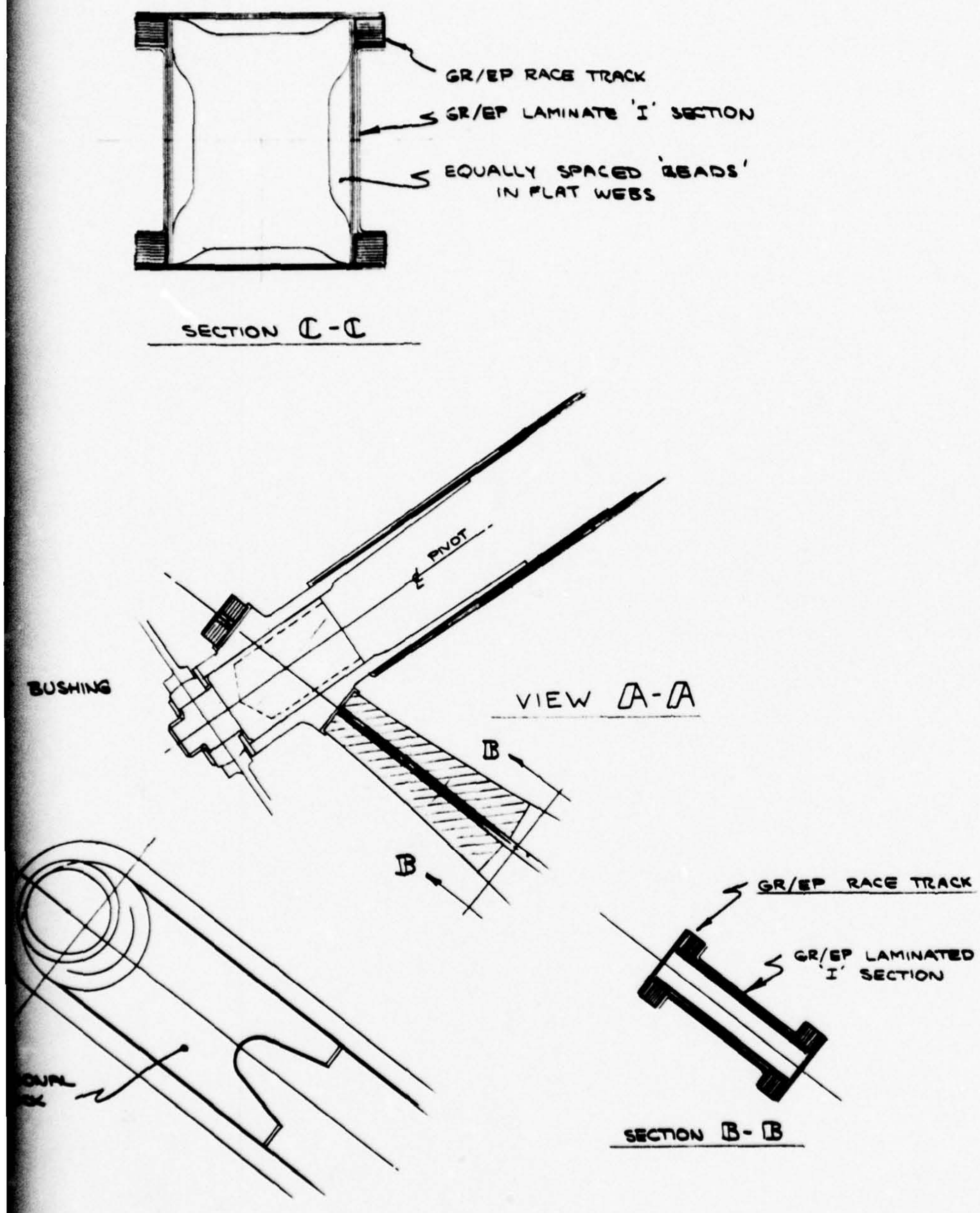


Figure 32.

SCALE			
1/10 & 1/2	DR. F. ATKINS DATE JUNE 28, '76 MODEL	Los Angeles Aircraft Division Rockwell International INTERNATIONAL AIRPORT · LOS ANGELES, CALIFORNIA 90009	ADVANCED DESIGN
STUDY – COMPOSITE NOSE GEAR COMPONENTS, PHASE I, CONCEPT 2-A			D615-1-407

3

has been added to the base of the torque link to relieve the load on the two outside lugs. The link will be "race track" wound over a solid laminated core.

The strut has retained the hydraulic-pneumatic load absorption features of the baseline strut. This concept uses the baseline piston. The cylinder and lower strut section is metallic, but uses titanium for better compatibility with composites. The inside titanium cylinder is bonded to the outside composite strut which is shaped like a flattened cone. This shape offers a good load path to the trunnion and is stiffened with horizontal bulkheads and vertical webs. The gear retract cylinder bell cranks are aluminum and are mounted on the trunnion pins and attached to the strut body by shear pins.

The wheel for Concept 2 is shown in figure 31. The configuration has been changed to spread out the bearings and to provide a direct load path from the tire beads down to the support points on the axle. The metallic axle sleeve,which is assembled with the wheel and bearings, has been retained since it improves maintainability by allowing wheel replacement on the "line" without handling the bearings.

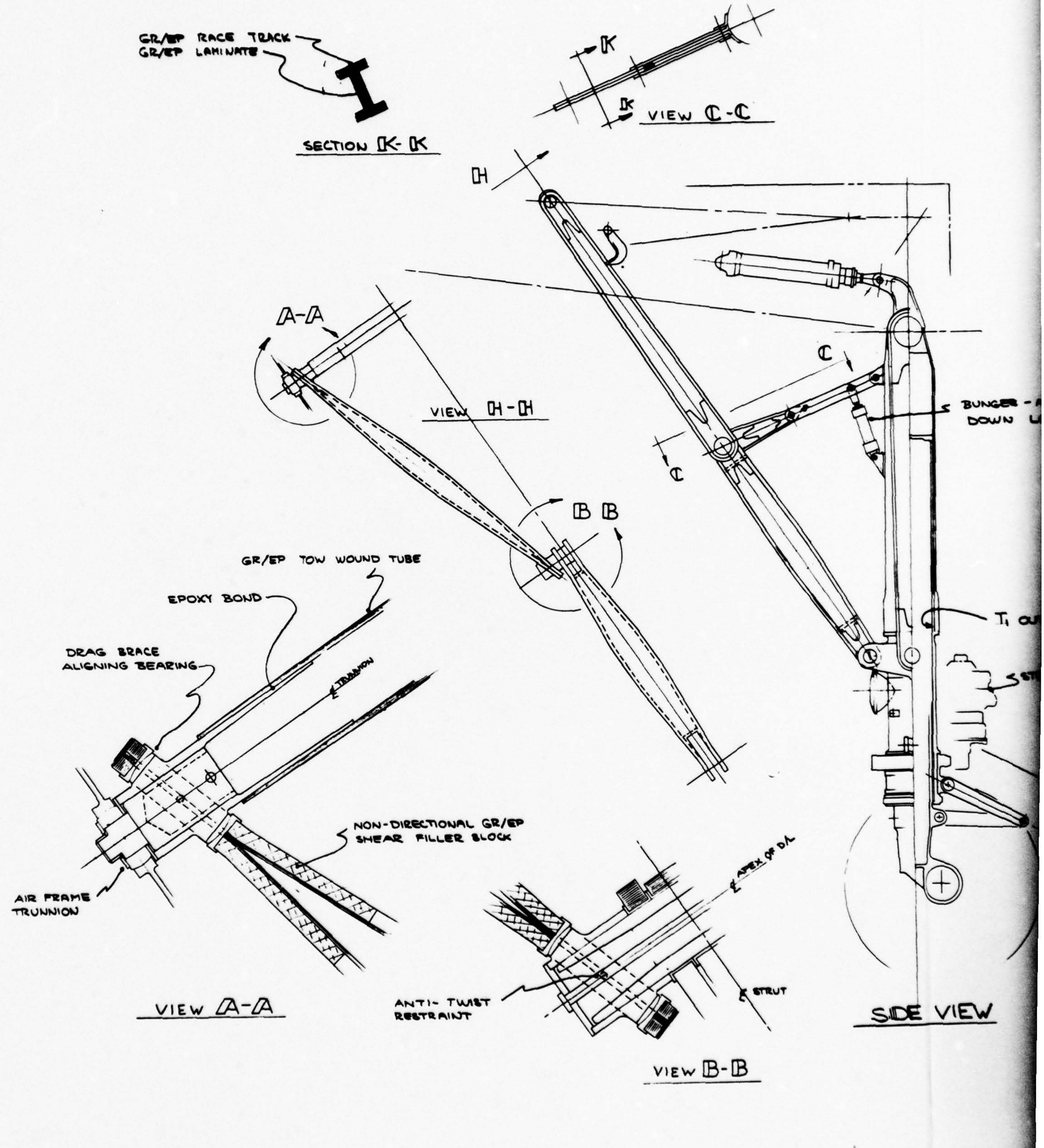
4.3.2 Concept 2 - Study B

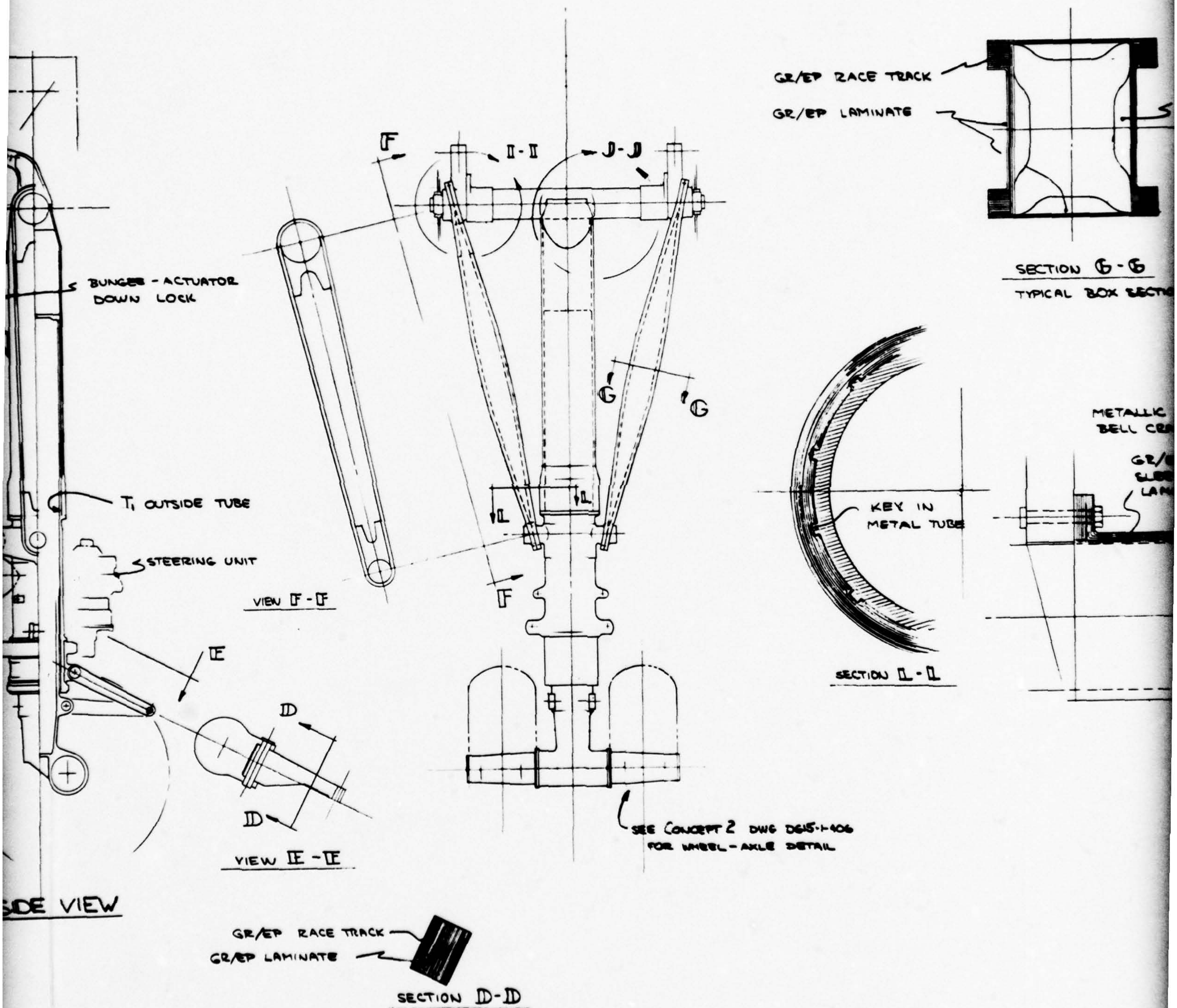
Kinematics of the B version of Concept 2 is approximately the same as the A version described in the previous section. The major change is in the configuration of the strut. This study uses axially loaded side braces to react the vertical loads and stabilize the strut for side loads. The drag brace reacts forward and aft loads the same as on Study A.

The strut consists of a titanium cylinder which has all the highly loaded lugs near the lower end. These include provisions for the drag brace, the side braces, the up lock pin and the steering mechanism. The location of the side braces at this position produces a larger side moment restraint arm, thus lowering the axial loads in the side braces. The center strut cylinder is keyed and bonded to the upper composite tube which will react the steering torque at the upper trunnion cross shaft. The nose gear retract cylinder bell cranks are aluminum and are bolted to composite sleeves attached to the trunnion shaft. (See figure 33.)

The configuration of the axially loaded struts, including the side struts, are "racetrack" caps on box sections, similar to the struts described in study A, except that the ends are provided with aligning features which reduce secondary bending moments from the truss.

Torque link lugs have been increased in span to provide a full width shear key effect. The axle hub on the piston has been increased in diameter to allow the use of a composite axle as shown in figure 33.


GR/EP RACE TRACK
GR/EP LAMINATE
SECTION K-K
K
K
VIEW C-C
H
A-A
VIEW H-H
C
C
B B
GR/EP TOW WOUND TUBE
EPOXY BOND
DRAG BRACE ALIGNING BEARING
℄ TRUNNION
NON-DIRECTIONAL GR/EP SHEAR FILLER BLOCK
AIR FRAME TRUNNION
VIEW A-A
℄ APEX OF D/L
℄ STRUT
ANTI-TWIST RESTRAINT
VIEW B-B
SIDE VIEW



BUNGEE - ACTUATOR
DOWN LOCK
T_1 OUTSIDE TUBE
STEERING UNIT
VIEW E - E
VIEW F - F
I - I
J - J
SEE CONCEPT 2 DWG D615-1-406
FOR WHEEL - AXLE DETAIL
GR/EP RACE TRACK
GR/EP LAMINATE
SECTION G - G
KEY IN
METAL TUBE
SECTION L - L
METALLIC
GR/EP RACE TRACK
GR/EP LAMINATE
SECTION D-D

2

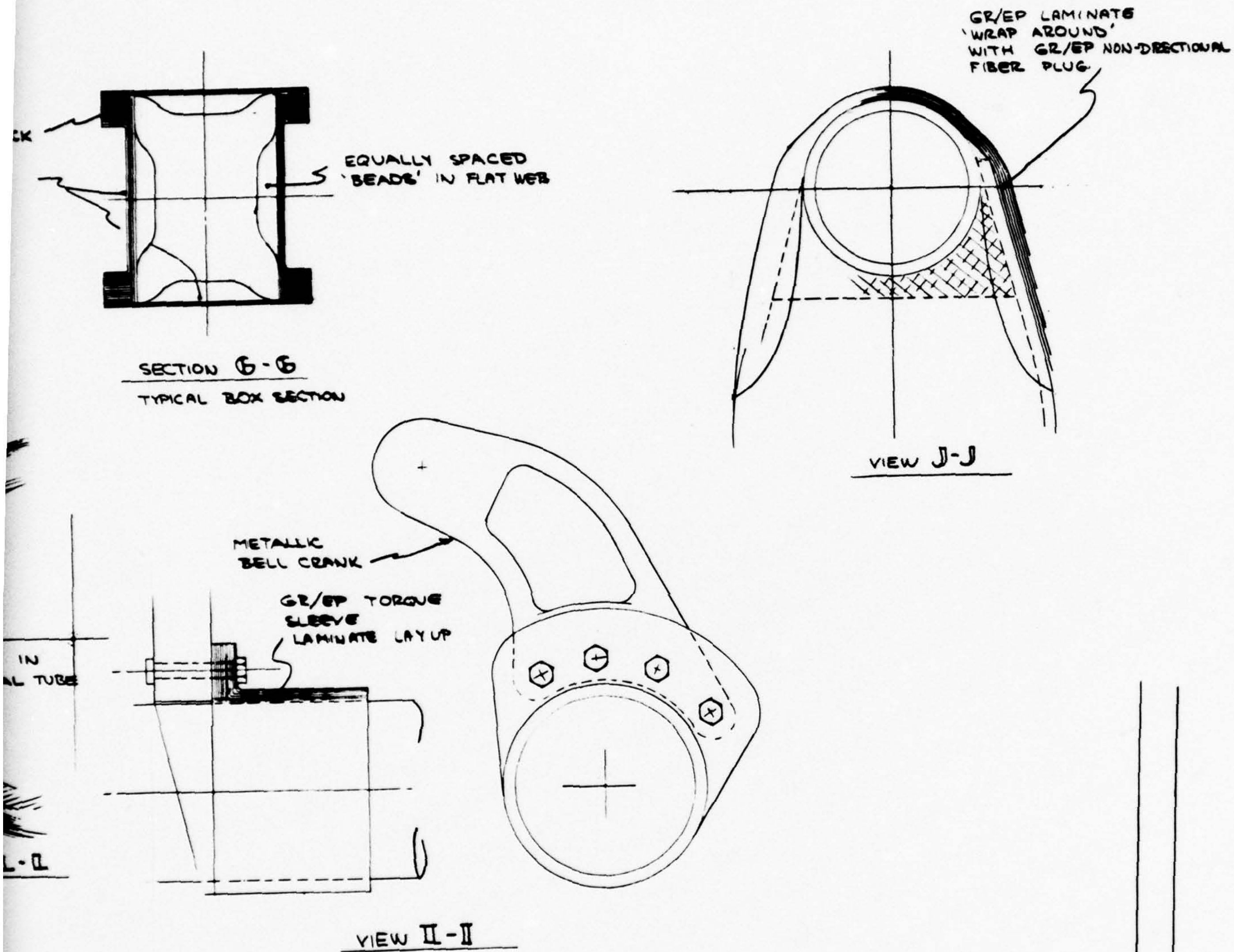


Figure 33.

SCALE:	DR. F. ATKINS DATE 7-26-76 MODEL	Los Angeles Aircraft Division Rockwell International INTERNATIONAL AIRPORT · LOS ANGELES, CALIFORNIA 90009	ADVANCED DESIGN
STUDY-COMPOSITE NOSE GEAR COMPONENTS, PHASE I, CONCEPT 2-B			D615-1-408

3

4.3.3 Display Model

A one-fifth scale working model of Concept 2-A will be built during the Phase II effort. This model will be mounted in a display case and will be manually extended and retracted, see figure 34. A shipping case will be furnished to protect the model and display case during transportation.

The model will be built to scale (1/5) and will be constructed from fiberglass, aluminum and wood. It will be sturdy enough to withstand transportation, handling and repeated operation of the extend-retract cycle. The model will operate the same as the actual landing gear except that it will be actuated by removing a latch pin and manually lowering the gear to the extended position. The drag links will unfold and the down lock links will "over-center" latch to hold the drag links in position. The retract procedure will consist of manually moving the down lock links off the over-center position and raising the gear to the retracted position and engaging the latch.

The display case will be constructed of aluminum, plexiglass and wood. It is designed so that the operation of the gear can be viewed from any direction. The case will be supported on four removable legs so that the gear can be lowered out the bottom of the case without interference. The legs will be removable so that the display case and stowed legs can be contained in a minimum sized shipping case. This case will be constructed from plywood. The case will be approximately 30 inches long, 14 inches high and 13 inches wide. The model, display case and shipping case will weigh approximately 27 pounds.

4.4 CONCEPT 3 - REDESIGN

Studies for Concept 3 were conducted to determine nose landing gear configurations which could foster the maximum practical use of composite material for landing gear hardware. With both the "form" and the "fit" constraints removed, the nose gear concepts were evaluated using only the "function" constraint.

The most innovative nose landing gear system studied was the composite "leaf spring" design shown in figure 35. This system uses a series of flat composite plates bonded to resilient material between them. The "leaf spring" will deflect and load up to absorb the kinetic energy, but it will also "kick-back" this energy so the resilient material between the leaves is necessary to reduce the high energy return. The problem is that the efficiency of a system like this is much lower than a hydraulic strut, thus causing the vertical axle displacement to be increased for the same energy absorption

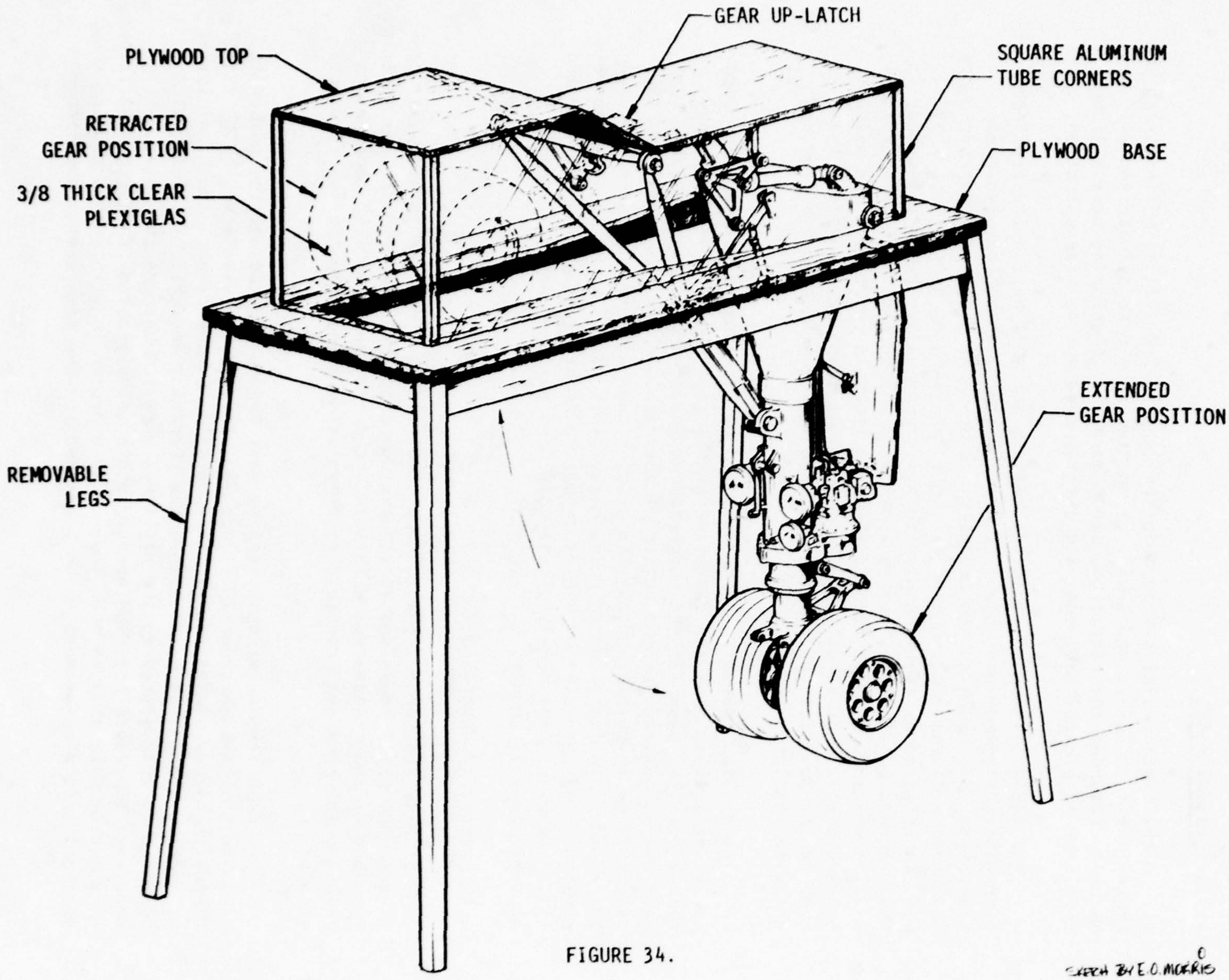


FIGURE 34.

SCALE MODEL - 1/5 SIZE AND DISPLAY CASE

SKETCH BY E.O. MORRIS
D/461 AAD 8-5-76

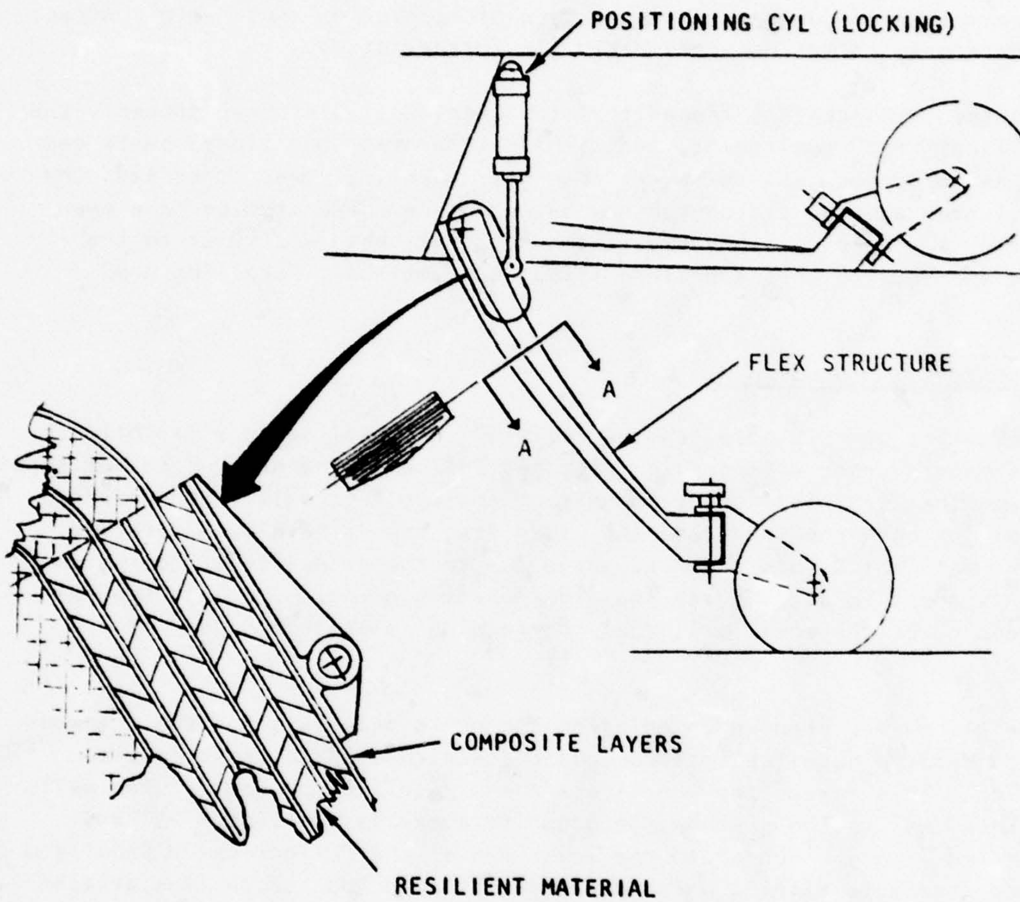


Figure 35. "Leaf Spring" Concept

requirements. Side loads on the wheel would create an undesirable torque load in the "leaf spring" strut. Stabilizing hardware would be required to hold the castoring axis to a near vertical position at all axle displacements. Preliminary studies suggest that this type of mechanism is not weight effective, therefore, it was not considered for further study.

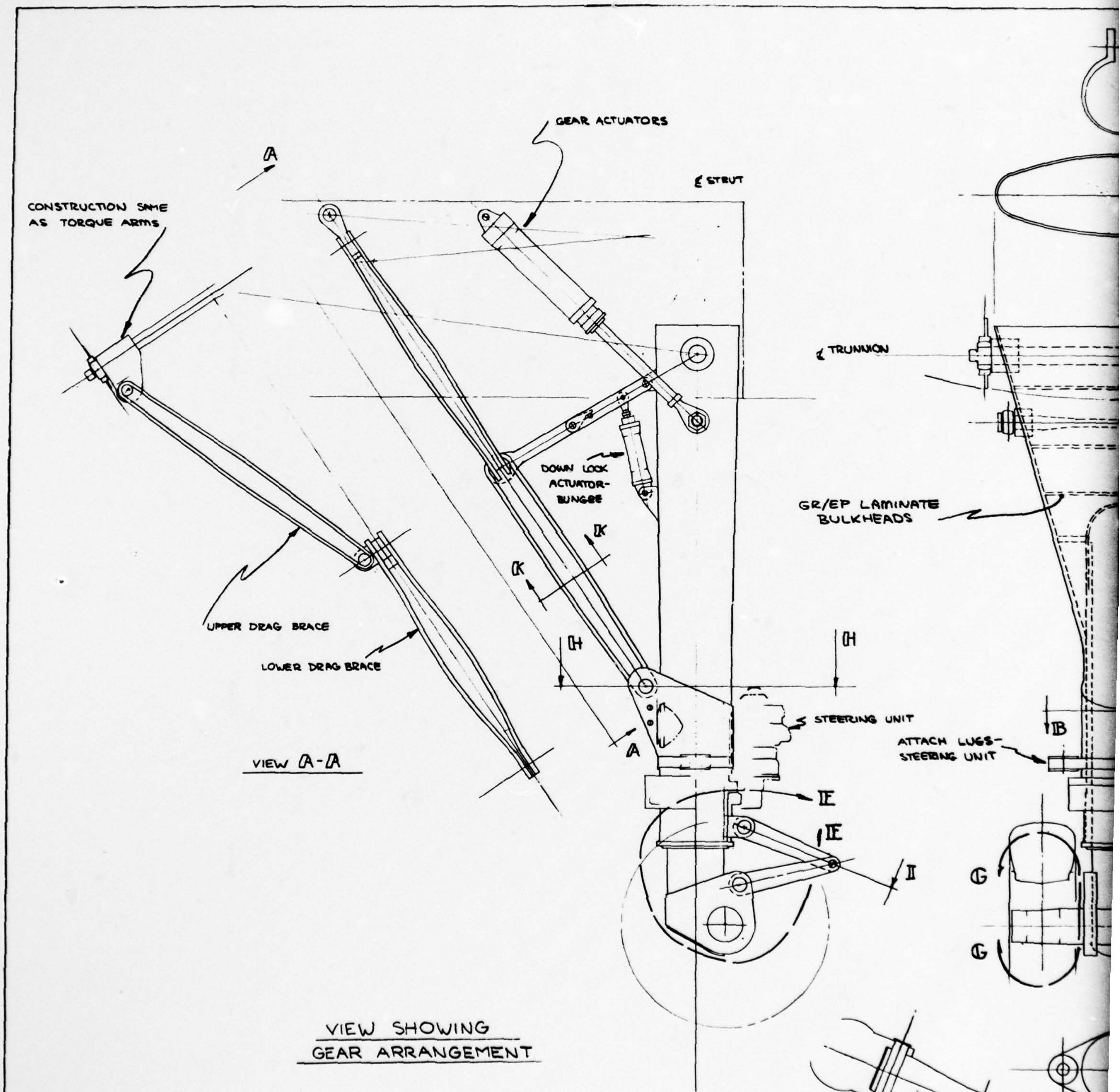
Studies in Concept II showed that the wheel well width was probably the most critical "fit" constraint, and with that removed, additional parts can be made using composites. With the nose gear wheels allowed to spread, the lower cylinder and the piston can now be composite. Two studies have been made for this concept. Study A uses a configuration very similar to the baseline and Study B uses a different, but conventional, "trailing arm" concept.

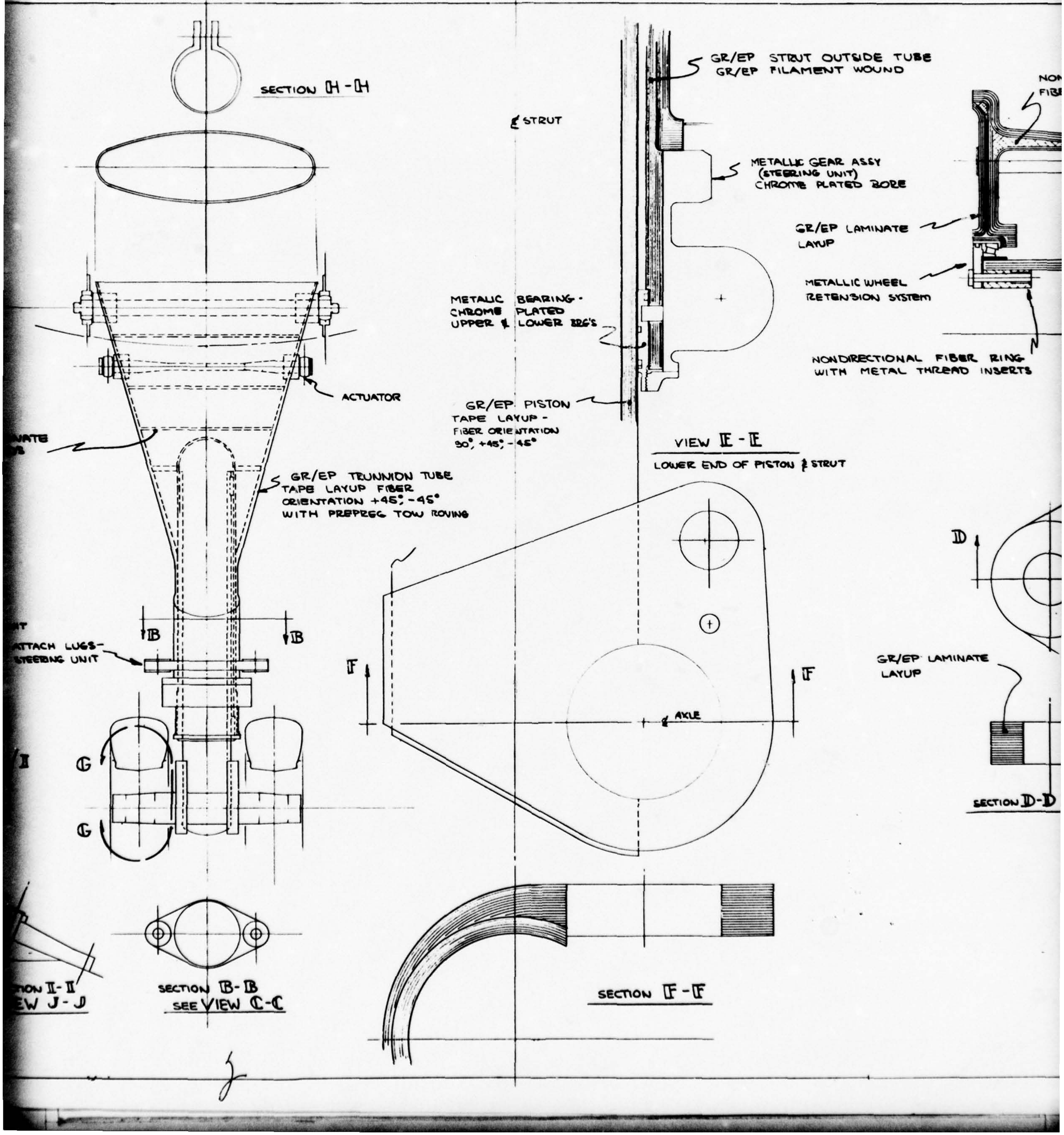
4.4.1 Concept 3 - Study A

Kinematics of this nose gear varies from the baseline only slightly in that the gear retract cylinder is relocated and pulls the gear up rather than pushing on the strut bell crank to retract it, see figure 36. The trunnion locations for both the strut and the upper drag braces have been retained. The wheel well volume has been increased due to the necessity of moving the side walls apart to accommodate the wider wheel spacing. The less than 2-inch widening of the wheel well does not require relocation of any major equipment.

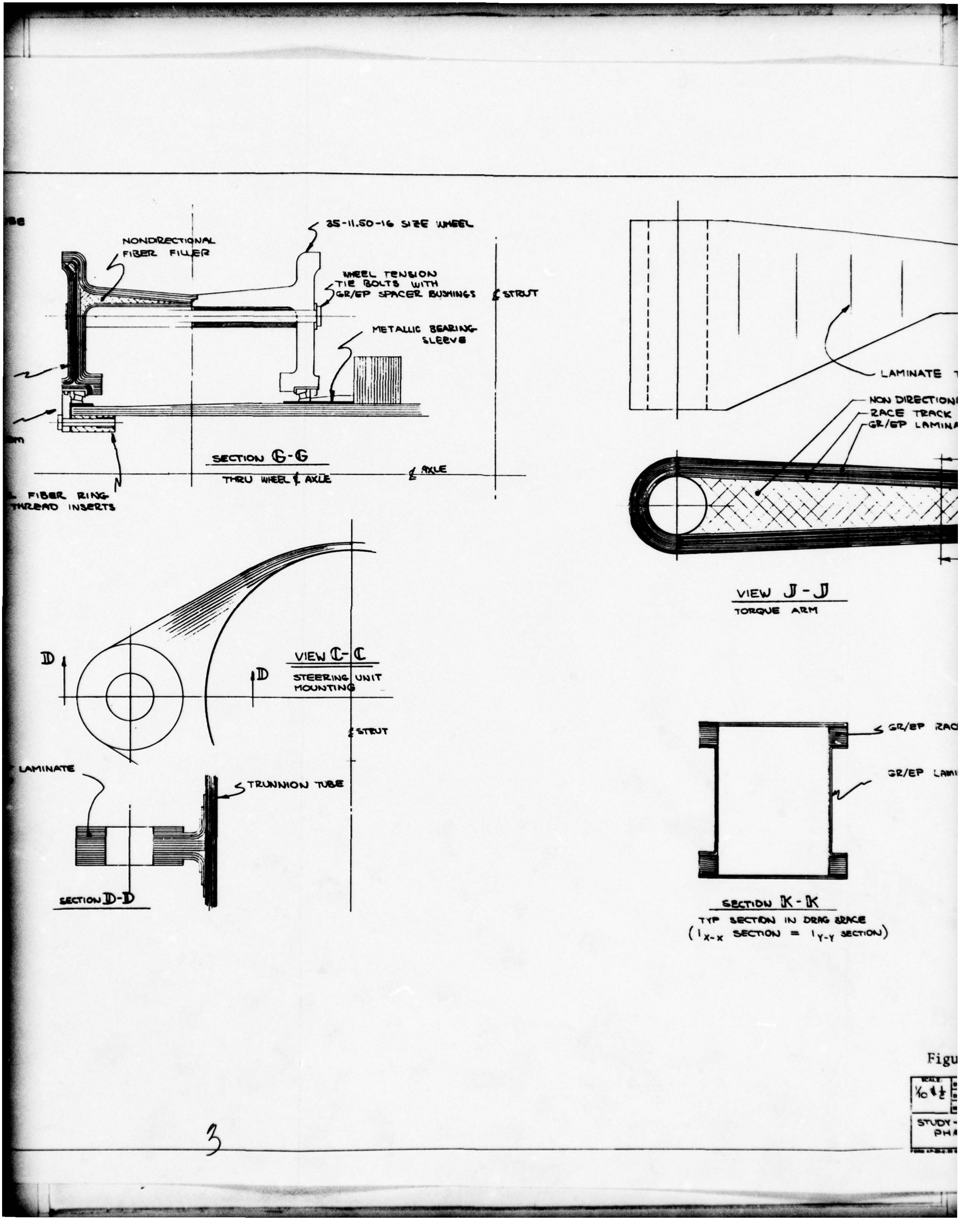
The piston has been designed using composite material, and the diameter enlarged over the baseline to accommodate the high loads using composite allowables. This forced the wheels apart and required moving the side walls of the wheel well. The piston is a graphite/epoxy layup using $\pm$ 45° and 90° oriented fibers. Bonded to the lower end of the cylindrical piston is a laminated composite fitting which provides for axle and torque link attachments. The piston moves up and down on chrome plated steel bearings which are fastened to the composite cylinder. The wear characteristics of this combination of materials has proven satisfactory (see reference 8) for the expected life cycles required for this application.

The inside cylinder of the strut is a graphite epoxy filament wound tube with a hemispherical top. This is the pressurized component of the strut. The internal hydraulic-puenematic load absorption system is similar to the baseline except for the larger diameter of the cylinder. The chrome plated steel bearings are bonded and pinned to the composite cylinder. The lower bearing ring is threaded to provide for an end ring which retains the metallic gear assembly of the steering unit. This steering system is similar to the baseline, but the diameter is larger to accommodate the composite cylinder.


GEAR ACTUATORS
A
℄ STRUT
CONSTRUCTION SAME AS TORQUE ARMS
℄ TRUNNION
DOWN LOCK ACTUATOR-BUNGEE
GR/EP LAMINATE BULKHEADS
K
UPPER DRAG BRACE
LOWER DRAG BRACE
H
STEERING UNIT
ATTACH LUGS-STEERING UNIT
B
VIEW A-A
E
I
G
VIEW SHOWING GEAR ARRANGEMENT
SECTION I-I
SEE VIEW J-J



SECTION H-H
℄ STRUT
GR/EP STRUT OUTSIDE TUBE
GR/EP FILAMENT WOUND
METALLIC GEAR ASSY
(STEERING UNIT)
CHROME PLATED BORE
GR/EP LAMINATE
LAYUP
METALLIC WHEEL
RETENSION SYSTEM
NONDIRECTIONAL FIBER RING
WITH METAL THREAD INSERTS
METALIC BEARING-
CHROME PLATED
UPPER ℄ LOWER BRG'S
ACTUATOR
GR/EP PISTON
TAPE LAYUP-
FIBER ORIENTATION
90°, +45°, -45°
VIEW E-E
LOWER END OF PISTON ℄ STRUT
GR/EP TRUNNION TUBE
TAPE LAYUP FIBER
ORIENTATION +45°, -45°
WITH PREPREG TOW ROVING
ATTACH LUGS-
STEERING UNIT
B
B
F
F
D
℄ AXLE
GR/EP LAMINATE
LAYUP
G
G
SECTION D-D
SECTION B-B
SEE VIEW C-C
EW J-J
SECTION F-F



NONDIRECTIONAL FIBER FILLER
35-11.50-16 SIZE WHEEL
WHEEL TENSION TIE BOLTS WITH GR/EP SPACER BUSHINGS
℄ STRUT
METALLIC BEARING SLEEVE
FIBER RING
THREAD INSERTS
SECTION G-G
THRU WHEEL ℄ AXLE
℄ AXLE
LAMINATE
NON DIRECTION
RACE TRACK
GR/EP LAMINA
VIEW J-J
TORQUE ARM
D
D
VIEW C-C
STEERING UNIT MOUNTING
℄ STRUT
LAMINATE
TRUNNION TUBE
SECTION D-D
GR/EP RAC
GR/EP LAMI
SECTION K-K
TYP SECTION IN DRAG BRACE
(I_{X-X} SECTION = I_{Y-Y} SECTION)
Figu
SCALE: 1/10 & 1/2
STUDY-
PHA
3

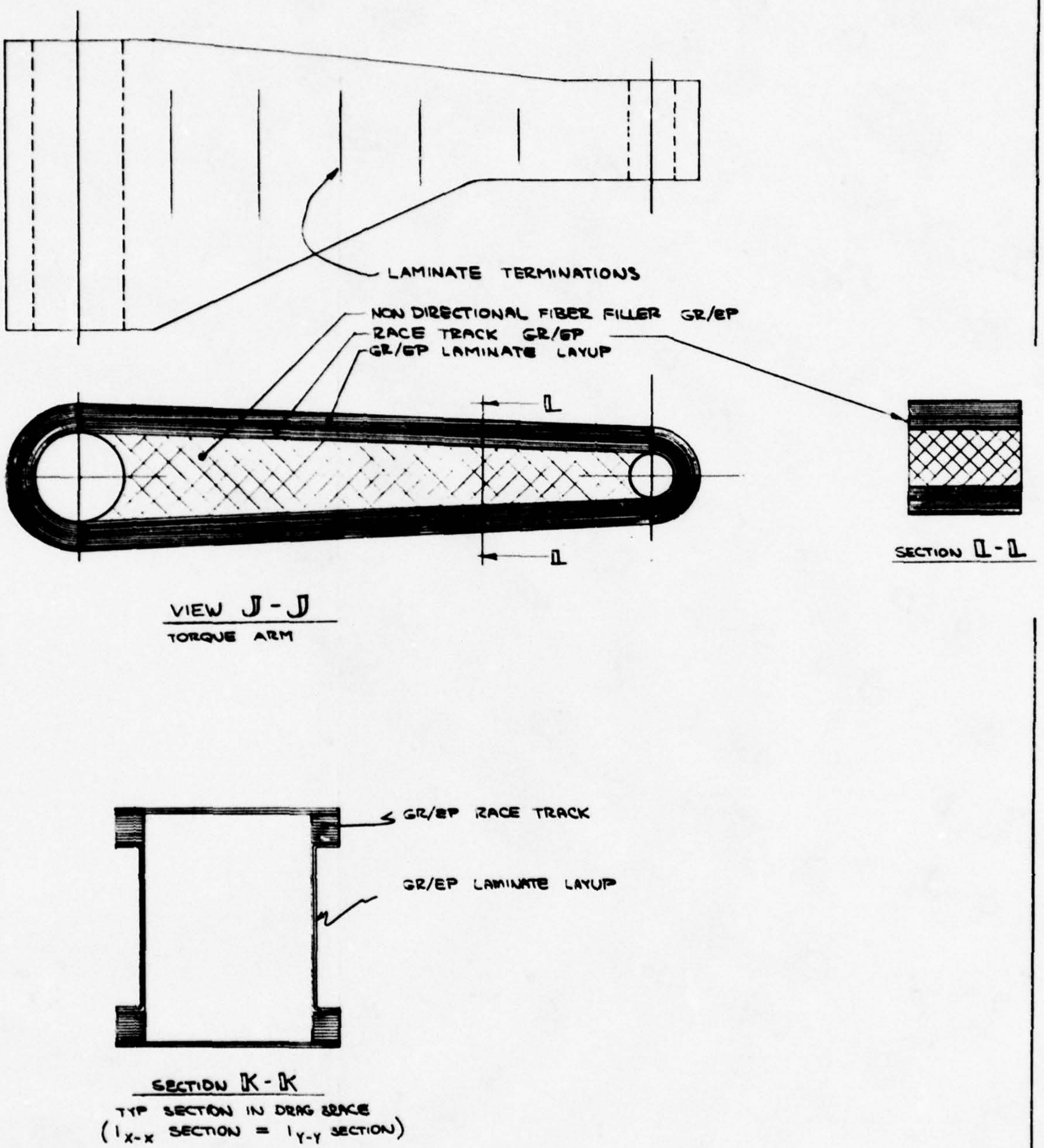


Figure 36.

SCALE: 1/10 & 1/2	DR. ATKINS DATE JULY 5/76 MODEL B-1	Los Angeles Aircraft Division Rockwell International INTERNATIONAL AIRPORT · LOS ANGELES, CALIFORNIA 90009	ADVANCED DESIGN
STUDY-COMPOSITE NOSE GEAR COMPONENTS PHASE I , CONCEPT 3-A			D516-1-409

4

The upper strut section is a flattened cone shape and is similar to Concept 2 except that the gear retract bell cranks have been eliminated and the actuator mounts directly to the strut body. Both the actuator and the main strut mounts are composite bushings, bonded to the strut. Through shafts connect the bushings to assure that no moment loads are imposed on the bushings. The drag strut and steering system lugs are laminated composite and are bonded to the strut. The clamp type drag brace lugs are bolted to assure that the bond to the strut is not subjected to peel loads.

The drag braces are "race track" wound caps with laminated webs similar to the Concept 2 braces except that the pins and end fittings are designed so that the axis of rotation is always normal to the drag brace webs so that the loads are always axial.

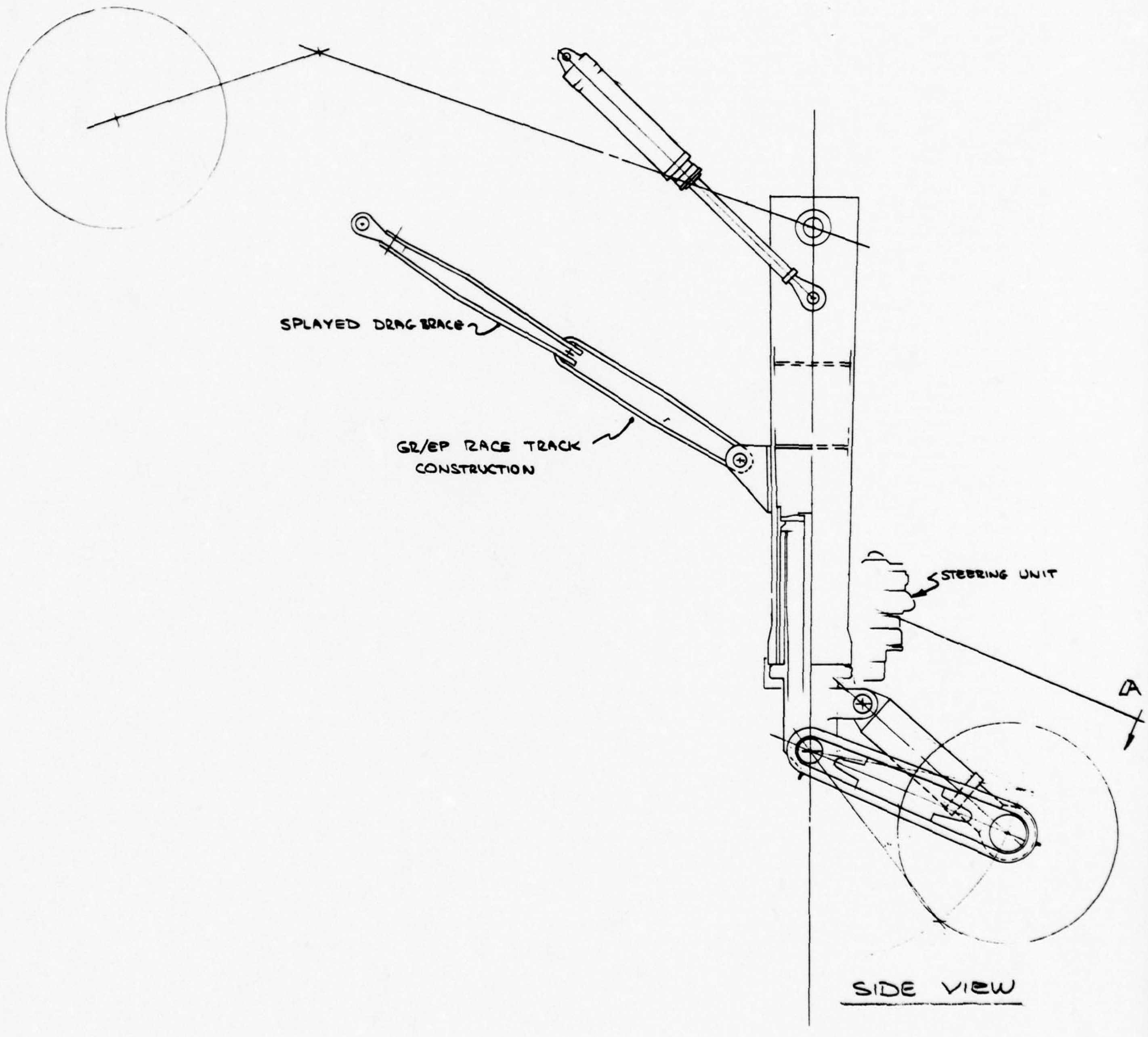
Torque links are similar in construction to the Concept 2 design except that the mounting lugs have been widened so that the base can be solid and act as a shear lug without the need to machine the base.

The wheel concept shown is similar to Concept 2 except that a machined fiber cylinder is used as a base filler in the rim section and composite spacer bushings are provided for the tension bolts joining the wheel halves.

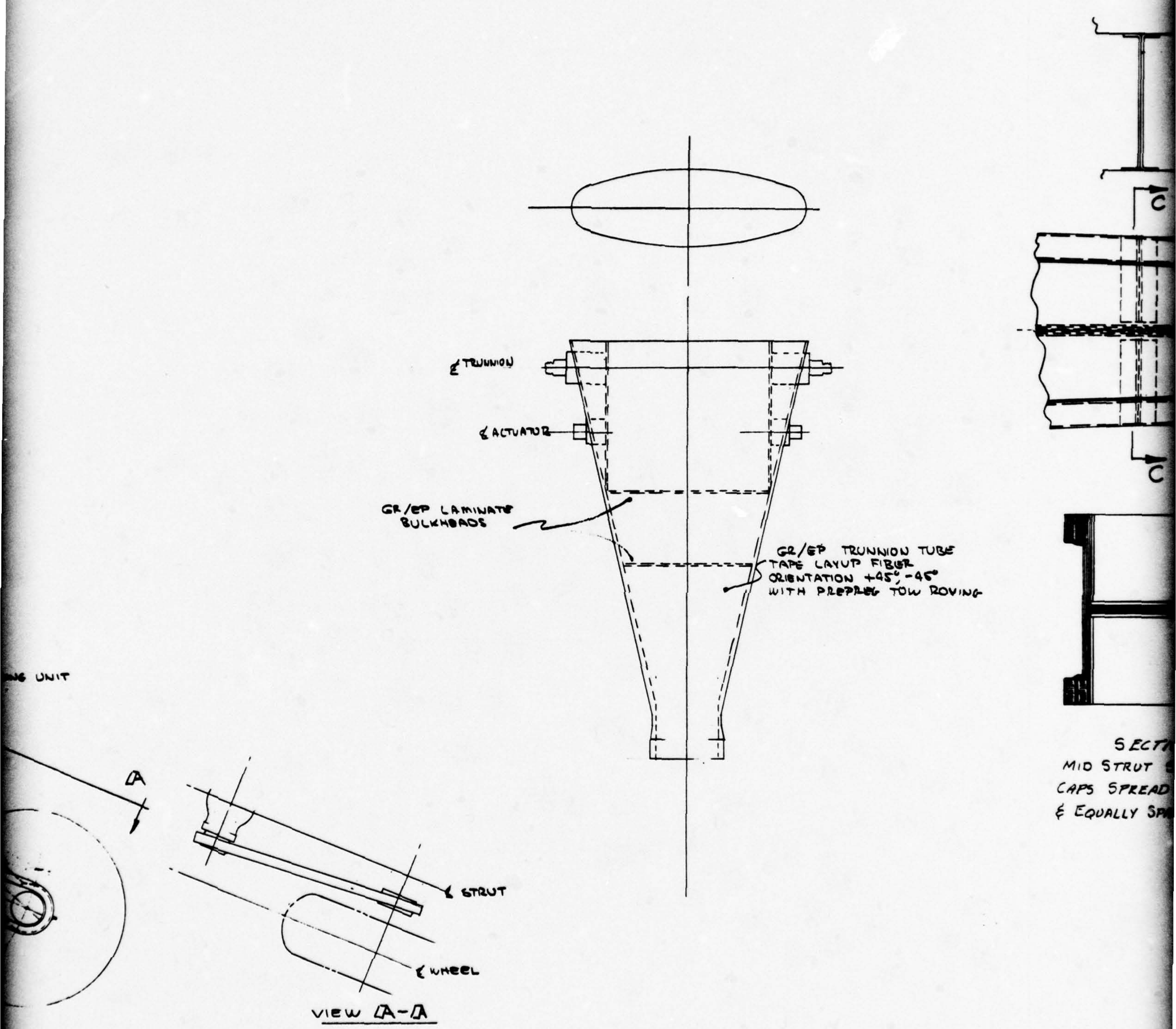
4.4.2 <u>Concept 3 - Study B</u>

The nose gear arrangement for this study is a departure from the baseline but still a conventional gear. It is a trailing arm concept with a vertical pivot for full circle steering capability, see figure 37. The steering unit can be similar to the baseline. The strut trunnion location has been retained, but the drag brace upper trunnions have been moved. The volume of the wheel well has been changed to accommodate this concept. The upper surface was raised and the side walls moved apart to provide clearance for the wheels. This change would require moving equipment as well as structure.

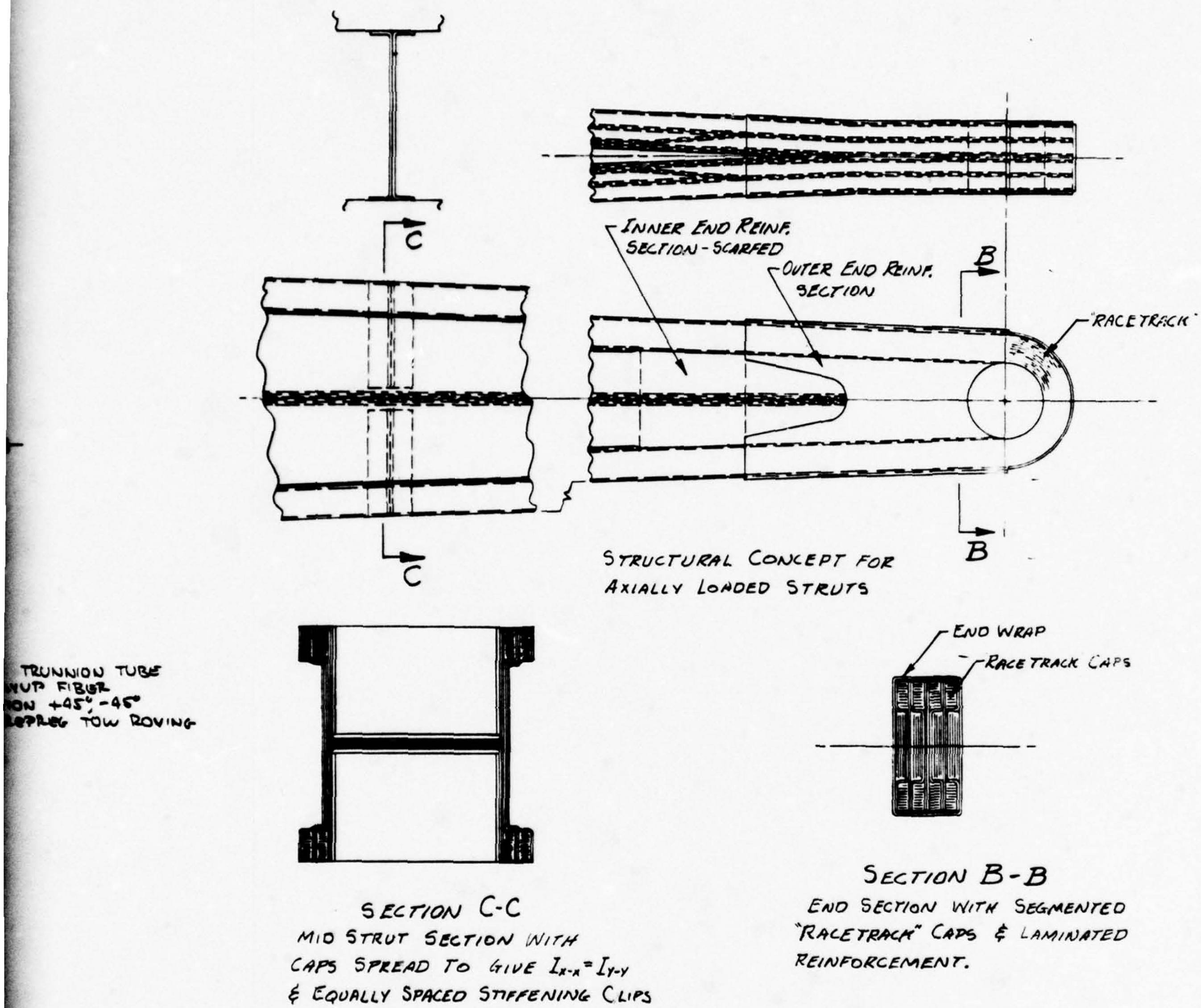
The drag braces and down locks are similar to that shown on Concept 3, Study A. The upper strut area is also similar except that the strut mounting and gear retract cylinder attach bushings are bonded to the outside wall of the strut and to an internal vertical web instead of having a through shaft as on Concept 3, Study A. The strut cylinder is not the shock absorbing system in this concept, but it does have provisions for the rotating stem of the vertical pivot. A composite sleeve is bonded to the inside of the strut and acts as the rubbing surface for the chrome plated steel stem.


SPLAYED DRAG BRACE
GR/EP RACE TRACK
CONSTRUCTION
STEERING UNIT
A

SIDE VIEW



CONCEPT III C



C

Figure 37.

SCALE: 1/10 & 1/2	DR. F. ATKINS DATE AUG. 1 '76 MODEL	Los Angeles Aircraft Division Rockwell International INTERNATIONAL AIRPORT - LOS ANGELES, CALIFORNIA 90009	ADVANCED DESIGN
STUDY - COMPOSITE NOSE GEAR COMPONENTS PHASE I CONCEPT 3-B			D615-1-410

3

The steel stem is integral with the gear for the steering system. The upper portion of the stem has two bearing areas which are chrome plated and bear against the composite sleeve. The lower end provides for the shock absorbing cylinder attach lugs and the pins for the trailing arm member.

The trailing arm member is a "U" shaped part with "race track" wound side wall beams and a bonded laminated bottom web. The beams are designed to react the axial loads and the bottom web, the shear load due to steering torque.

The structural concept for axially loaded struts is designed to use multiple narrow "race track" caps which are bonded to the webs by wrapping the webs around the caps. This provides a better tie between them by increasing the bond area and force them to work together and reduce the potential for cracking at the interface.

A one-fifth scale model of Concept 3-A will be built during the Phase II effort. The model and display case will be similar to that described for the Concept 2 model, see figure 34.

SECTION V

METHODOLOGY

This section describes the methodology which will be used to provide the data necessary to assess and illustrate the payoffs from the use of composite material for landing gear hardware. These data will be used to generate plots showing potential initial cost savings, life-cycle cost savings, and total weight reduction versus percent by weight of composite material in the landing gear.

5.1 DESIGN

The design concepts selected in Phase I for further study will be analyzed to see how improvements can be made to optimize the use of composites to produce a more efficient design. Inputs from the materials, structures, producibility and reliability sections will be used to modify the design concept. A preliminary design drawing will then be made. It will show critical dimensions, material identification, layup orientation, gages, and type of construction.

The drawing will then be routed to these same sections for checking to see whether further improvements can be made to the part. After incorporating the changes, if any, the preliminary design drawing will be sent to the reliability, logistics, cost and weight groups for analysis. See figure 38.

5.2 MATERIALS

During Phase II the designs will be evaluated to assure that the resin and fiber system is optimum and that fabrication processes planned for the part will produce a viable composite part. Conferences will be held with design and fabrication personnel to determine if design changes can be made to improve producibility and whether feasible manufacturing techniques can be developed to produce more efficient structural parts.

5.3 STRUCTURAL ANALYSIS

During the Phase II effort a structural analysis of the preliminary designs will be made to assure that sizing of the parts is realistic and that weights can be calculated with the required degree of accuracy. The gear components can be considered generally as elements subjected basically to axial tension compression and/or beam bending loads.

The material strength allowable and elastic properties will be generated using the AC-50/AC-50A programs described on page 77. The local strength

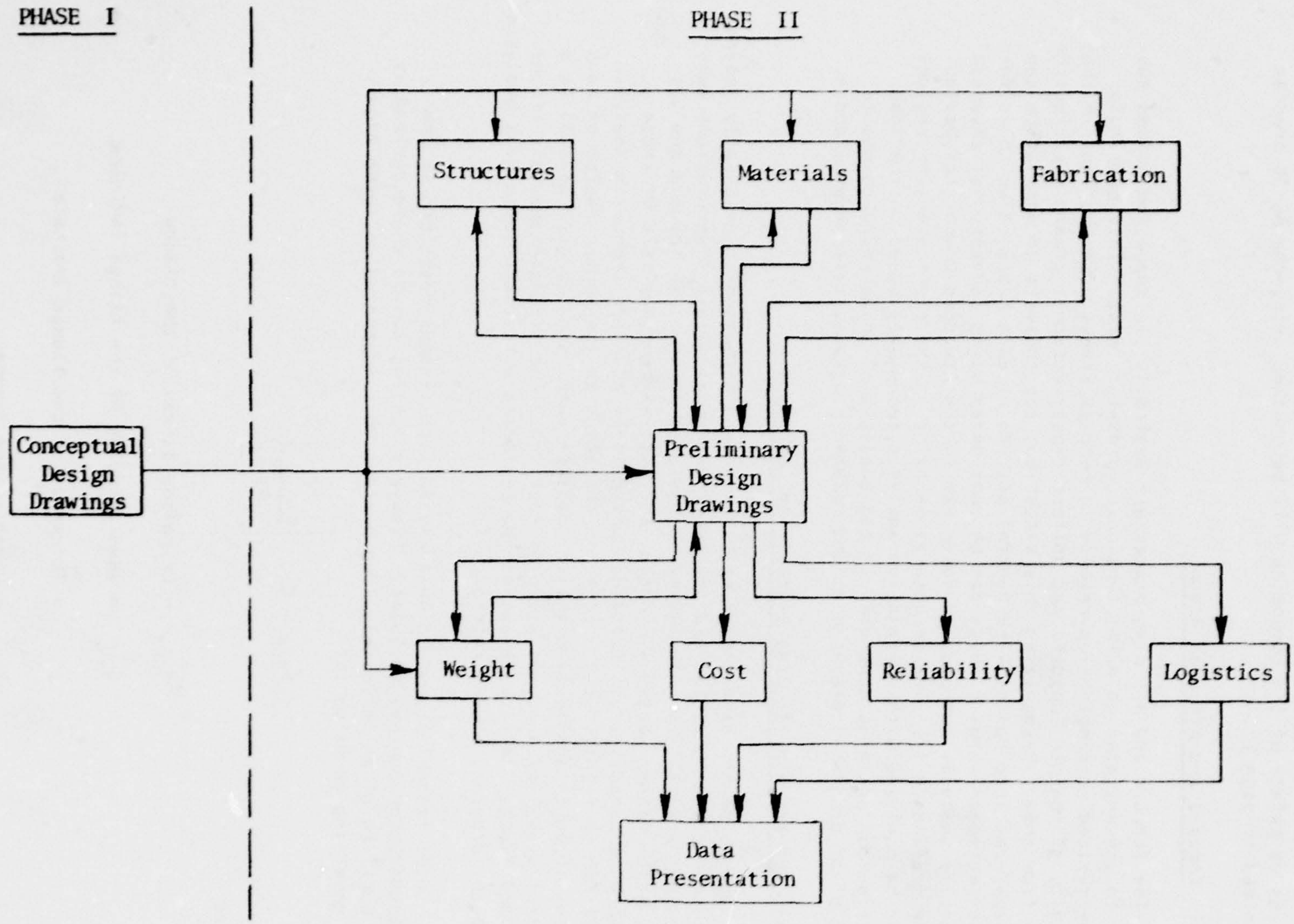


Figure 38 Phase II Flow Chart

margins of safety of the composite will be checked using the AC-3R program described on page 77.

5.3.1 Forward and Aft Drag Braces

The forward and aft drag braces are basically pin supported colums subject to concentrated uniaxial tension compression loads. This particular geometry-loading combination results in complex stress distributions in the vicinity of the pin supports and uniform cross-sectional strain distribution away from them. Recognizing this situation, the analysis of each brace can be separated into parts. The central portion of each brace in which uniform cross-sectional strains exist can be considered using conventional advanced composite analysis methods, as described in the Advanced Composites Design Guide (reference 1). The structural behavior in the pin connection regions would be analyzed with correlative analysis techniques based on the load distribution patterns generated in the analysis of an advanced composite wing pivot program (reference 2) and related programs, references 3 and 4.

5.3.2 Forward and Aft Drag Brace Center Sections

Due to de St. Venant's principle, the end effects of a uniaxially loaded long column are localized and the cross-sectional strain distributions away from them are uniform. The latter behavior exists in the forward and aft drag brace center sections. Hence, a finite-element analysis of these regions is unnecessary. Existing conventional advanced composite analysis tools can be readily used. To fully characterize the center region of each brace, strength and local stability of their webs and flanges, as well as a general stability analysis would be required. The strength analysis of the web and flange laminate layups can be performed with the point stress analysis computer program, AC-3R (reference 1).

Local instability would be analyzed with methods described in the Advanced Composite Design Guide. Flange crippling can be characterized as the buckling of an infinitely long plate simply supported on three edges. Its governing equation is:

$$F_{CCR} = G_{XY} \left[\frac{t_f}{b_f} \right]^2$$

where

F_{CCR} = Crippling stress of the flange

G_{XY} = Shear modulus of the flange laminate

t_f = Thickness of the flange laminate

b_f = Width of the flange

Local buckling of the brace web can be idealized as the buckling of an infinitely long panel simply supported on all four edges whose failure equation is:

$$N_{X,CR} = \frac{2\pi^2}{b_w^{\,2}}\left[\sqrt{D_{11}D_{22}} + D_{12} + 2D_{66}\right]$$

where

$N_{X,CR}$ = Buckling load per unit length of web

b_w = Width of web

D_{ij} = Flexural rigidities of the web laminate

General stability of each brace can be considered using the equation

$$P_{CR} = \frac{K\pi^2 \overline{E}_x I}{L^2}$$

where

P_{CR} = Brace buckling load

E_x = Equivalent axial modulus

I = Moment of inertia of the brace cross - section

L = Distance between pin supports

K = End restraint coefficient

Buckling behavior in the two planes of symmetry of each brace must be considered.

Redesign of the brace center region cross - section would be performed if any of these analyses indicated unacceptable structural behavior in that member.

5.3.3 Pin Connection Regions

The complex nature of the stress distribution, caused by the concentrated applied loads in the vicinity of the pinned ends of each brace, necessitates a local analysis of typical ends to ensure the adequacy of their design. Provided that the geometry and applied loading of each pin end are similar to the concept considered in the AFFDL technical report, "Preliminary Design and Analysis of an Advanced Composite Wing Pivot Structure" (reference 2), a correlation may be drawn as to the load introduction patterns and resulting stress distrubtions from the results of this program. However, the accuracy of this analysis/internal loads generation shall only be as efficient as the initial assumptions made in comparing the separate design concepts. To initially size the developed design concepts, an iteration of a point stress analysis computer program, AC-3R, will be required to check the developed margins-of-safety.

5.3.4 Upper and Lower Downlock Arms

The upper (aft) and lower (forward) downlock arms are tension-compression axially loaded members with transverse loads introduced by the downlock actuator on the upper (aft) arm at one end and the off-center reaction loads at the juncture of the upper and lower arms. This results in combined axial and bending loaded members (beam-column) which will be analyzed using procedures previously described for the drag brace components and from references 1 and 5.

5.3.5 Tubular Strut Assembly

The primary loading conditions are those of (tension/compression) fatigue and beam column bending. The fixity of this element allows the use of conventional advanced composite analysis methods (reference 1) for tubular shells. These methods are based primarily on orthotropic shell theory and employ little or no computer analysis. However, once material allowables have been generated and a preliminary sizing developed for known loads, the point stress analysis program, AC-3R (reference 1) will be implemented to develop appropriate margins of safety and thus determine the necessity of design iterations.

5.3.6 A-Frame Truss Assembly (Trunnion)

The A-frame truss structure (trunnion), which supports the tubular strut assembly, may be idealized as pinned at the upper fuselage pivot attachments and statically determined. This simplification lends itself to the use of conventional advanced composites analysis methods (reference 1) for beam

column theory. In this manner, tension, compression and beam bending, as well as local instability and fatigue loads, may be resolved without the use of computer programs. However, the pinned end of the structure may be subject to complex loads distributions due to the induced combined loading conditions and complex part geometry. Therefore, the lug attachments of the truss assembly will be analyzed similar to the pin connection regions of the drag braces previously described.

5.3.7 Torque Arm Link

The torque arm links, transmit the turning loads from the wheel-lower-piston assembly to the tubular strut assembly. The upper and lower arms are linked to allow extension or retraction of the piston assembly into the strut assembly.

The torque arms can be considered a cantilever beam type structure loaded at one end and reacted by shear and couple loads at the opposite end. The reacting couple loads are perpendicular to the applied end load direction.

Tension, compression, and shear loads can be developed based on a strength of materials approach with sufficient accuracy to determine preliminary structural sizing. The point stress analysis program, AC-3R (reference 1) will be used when material orientation, and known internal loads are established. This will develop the combined loads margins of safety and thus determine the necessity for any further design modifications.

5.3.8 Wheel Analysis

The analysis of the wheel will be performed using a strength of materials approach. The geometrical constraint of form fit and function necessitates a wheel geometry very similar to the metal baseline, but with the avoidance of sharp corners and the use of increased wall thicknesses to reduce shear stress levels and tapered thicknesses to provide smooth load transitions. Methods provided in references 1, 5, and 6 will be used.

5.3.9 Axle-Piston

The axle-piston components will be preliminary analyzed using the strength of materials approach. Where composite materials are used, the methods described for the drag brace will be used.

5.3.10 Spreader Bar

The spreader bar transmits the two forward drag brace loads into the drag brace support points in the fuselage through localized bending. Also,

the spreader bar ties both the left and right hand forward drag braces together as a truss unit. A strength of materials approach will be used to determine preliminary structural sizing. Where composite materials are used, the methods described for the drag brace will be used.

5.3.11 AC-50/AC-50A Design Strength and Characterization for Advanced Composites

These two linear analysis computer programs will be used to provide material property input to program AC-3R by calculating initial laminate failure strength, final failure strength and synthetic design allowable strength (for either stress or strain design criteria), elastic properties, and physical constants for cross-plied advanced composite laminates. Program AC-50 produces carpet plots in numerical and graphical form (see figures 40 and 41) for the $[0/\pm\theta/90]_S$ family of laminates. Program AC-50A calculates these numbers for any layup with up to 10 different orientations and materials.

5.3.12 AC-3R Margin-of-Safety Calculations

This program calculates; (1) the laminate flexural and extensional constants when treated as a set of laminae (Aij, B_{ij}, and D_{ij}) or as an orthotropic homogeneous material (E_x, E_y, G_{xy}, υ_{xy} and $\upsilon_{xy}0$; and (2) the stresses, strains, and margins of safety for prescribed layers, given the external loads. The prescribable external loads are the inplane (Nx, Ny, and Nxy), rotational (Mx, My, and Mxy), and transverse (Qx, Qy,) stress resultants at a point (figure 39) as well as the temperature differential (ΔT) within each layer. The transverse shear stresses, Sxy and Syz, are only computed when the laminate is prescribed to be symmetric.

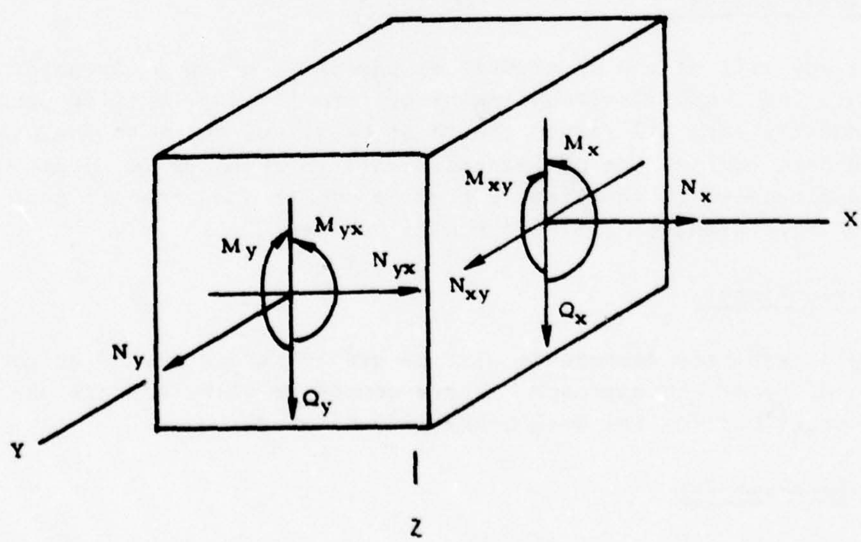


Figure 39. Structural Element Applicable External Loads

AC-50 MATERIAL PROPERTY GENERATION

EX
MATERIAL IS B/EP AT R.T.

VERTICAL AXIS IS PERCENTAGE OF 0.0 DEGREE PLIES
HORIZONTAL AXIS IS PERCENTAGE OF +- 60.0 DEGREE PLIES
BALANCE IS 90.0 DEGREE PLIES

100 *	30000.										
90 *	27319.	27230.									
80 *	24598.	24604.	24449.								
70 *	21867.	21913.	21862.	21663.							
60 *	19132.	19200.	19200.	19105.	18876.						
50 *	16395.	16477.	16507.	16467.	16339.	16088.					
40 *	13657.	13749.	13798.	13794.	13723.	13567.	13298.				
30 *	10919.	11017.	11080.	11100.	11067.	10969.	10791.	10509.			
20 *	8179.	8283.	8356.	8393.	8387.	8329.	8209.	8012.	7719.		
10 *	5440.	5548.	5629.	5679.	5692.	5663.	5584.	5444.	5231.	4928.	
0 *	2700.	2812.	2899.	2959.	2988.	2980.	2931.	2832.	2675.	2448.	2138.
	* 0	* 10	* 20	* 30	* 40	* 50	* 60	* 70	* 80	* 90	* 100

Figure 40. Typical Material Property Data Output

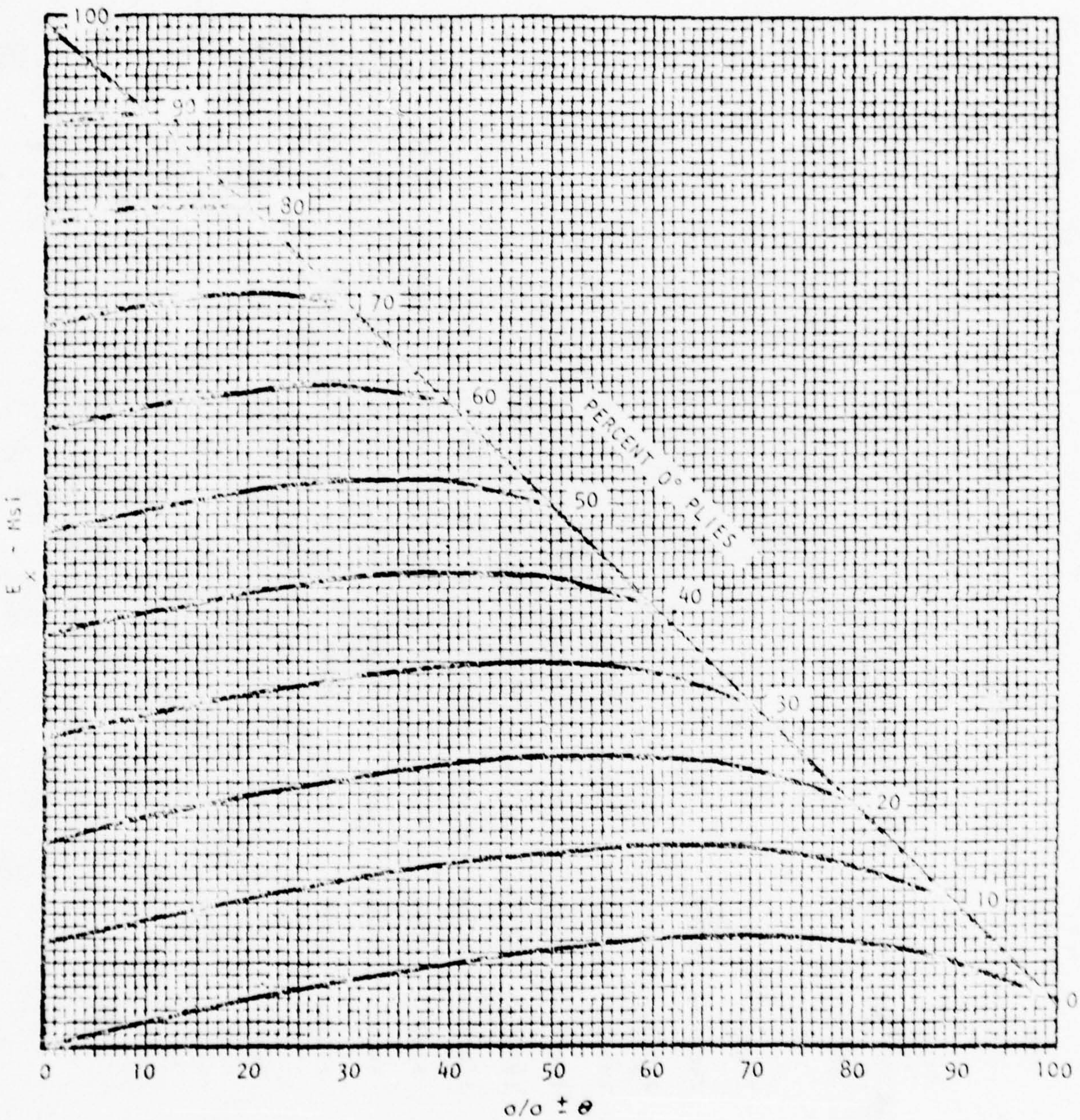


Figure 41. Typical AC-50 Material Property Carpet Plot

Lamination theory is used in the calculations. Two types of margin of safety may be computed:

1. The strength criteria (where R = stress resultant)

$$R_L \leq 1 \qquad \text{(fiber)}$$

$$R_T^2 + R_{LT}^2 \leq 1 \qquad \text{(matrix)}$$

$$R_L = \frac{f_L}{F_L}$$

$$R_{LT} = \frac{f_{LT}}{F_{LT}}$$

2. The strain criteria

$$R_{LT} \leq 1$$

$$R_T \leq 1$$

$$R_{LT} \leq 1$$

$$R_i = \frac{\xi i}{\xi i \text{ (allowable)}}$$

The margin of safety is defined as the amount that all the stress resultants R must be increased in order that the laminate reach the incipient failure condition (i.e., the equality holds).

As can be seen in figure 42, either stress or strain (fiber or matrix) failure conditions may be easily recognized and the need for design/sizing iterations assessed. The problem illustrated is for an AVCO 5505 $[0/\pm 45/90]_S$ cross-plied boron/epoxy laminate at room temperature, under combined loading conditions (N_X = 2000 lb/in., N_Y = 1000 lb/in., and N_{XY} = 500 lb/in.). It can be readily seen that the lowest margin of safety generated is 3 percent and matrix (strain is critical.)

5.4 MASS PROPERTIES

Preliminary design drawings generated during the Phase II effort will be used to develop the required mass properties. Weight and center of

```
                    P O I N T   S T R E S S   A N A L Y S I S - A C 3

          (REFERENCE CH. 2.1 OF THE ADVANCED COMPOSITE DESIGN GUIDE - THIRD ED.)

               INPUT DATA                                                    NOMENCLATURE

  NL=  8          NM= 1          NS=-2          NLD= 1              NL=NO. LAYERS
       PRINT DATA FOR LAYERS  1,  4,  1                              NM=NO. MATERIALS
     THE STRESS FAILURE CRITERIA IS USED                             NS=NO. SETS
                                                                    NLD=NO. LOAD CONDITIONS
       MATERIAL   1 IS  AVCO 5505 AT R.T.                              E=YOUNGS MODULUS
                                                                       U=POISSONS RATIO
 E(L)= 30000000.      E(T)=  2710000.     G(LT)=   700000.        ALPHA=COEF. THERMAL EXPANSION
U(LT)= 0.2130      ALPHA(L)= 0.0000023 ALPHA(T)= 0.0000106            EPS=AXIAL STRAIN
    DEFAULTS            TAU=     0.0   THICKNESS= 0.0052              CHI=ROTATIONAL STRAIN
SIGA(L)= 192000.     SIGA(T)=  10400.    SIGA(LT)=  15300.        N,M,Q=AXIAL,MOMENT,SHEAR LOAD
SIGA(L)=-353000.     SIGA(T)= -40000.                             NT,MT=N,M DUE TO TAU
                                                                    TAU=TEMPERATURE DIFFERENTIAL
                                                                    SIG=APPLIED STRESS
                        LAYER DATA                                 EPSA=ALLOWABLE STRAIN
LYR MAT  THETA  THICK.   TAU        LYR MAT  THETA  THICK.   TAU      SIGA=ALLOWABLE STRESS
 1   1    0.0  0.0052    0.          5   1   90.0  0.0052    0.    SIGBAR=AVERAGE STRESS
 2   1   45.0  0.0052    0.          6   1  -45.0  0.0052    0.
 3   1  -45.0  0.0052    0.          7   1   45.0  0.0052    0.
 4   1   90.0  0.0052    0.          8   1    0.0  0.0052    0.

                       LAMINATE DATA                                       SUBSCRIPTS
        A(I,J)                                   B(I,J)              (L,T,LT)=LAMINATE DIRECTIONS
532818.  174039.        0.          -0.0      -0.0       -0.0        (X,Y,XY)=LAMINATE DIRECTIONS
174039.  532918.        0.          -0.0       0.0       -0.0
    0.       0.    179399.          -0.0      -0.0       -0.0
        B(I,J)                                   D(I,J)                        FORMULAE
  -0.0      -0.0      -0.0        127.13     21.04       7.71      N(I)+NT(I)=A(I,J)*EPS(J)+B(I,J)*CHI(J)
  -0.0       0.0      -0.0         21.04     34.67       7.71      M(I)+MT(I)=B(I,J)*EPS(J)+D(I,J)*CHI(J)
  -0.0      -0.0      -0.0          7.71      7.71      21.81
                                                                    FAILURE DOES NOT OCCUR IF R( ).LE.1
  E(X)= 11441601.     E(Y)= 11441599.    G(X,Y)=  4312245.                  STRESS CRITERIA
U(XY)=     0.3266   U(YX)=     0.3266   THICKNESS= 0.0416             R(FIBER)=SIG(L)/SIGA(L)
                                                            R(MATRIX)=(SIG(T)/SIGA(T))**2+(SIG(LT)/SIGA(LT))**2
NT(X)=       0.0    NT(Y)=       0.0    NT(X,Y)=        0.0                  STRAIN CRITERIA
MT(X)=       0.0    MT(Y)=       0.0    MT(XY)=       0.0            R(L,T,LT)=EPS(L,T,LT)/EPSA(L,T,LT)
                                         LOAD CONDITION  1

    N(X)=    2000.00   (Y)=     1000.00   (XY)=      500.00        M(X)=       0.0   (Y)=       0.0   (XY)=       0.0
    Q(X)=        0.0   (Y)=         0.0
  EPS(X)= 0.0035157   (Y)= 0.0007285   (XY)= 0.0027872     CHI(X)=-0.0000000  (Y)=-0.0000000  (XY)=-0.0000001
SIGBAR(X)=    48077.   (Y)=    24038.   (XY)=     12019.
LYR         QBAR(I,J)-KSI                 ALPHA             - - - - - - SIG( )-KSI - - - - - - -              M.S.

 1     30120.      571.        0.   (X)= 0.0           (X)= 106.31 (L)= 106.31 (XZ)=   0.0     (FIBER)=  0.806
          571.     2721.        0.   (Y)= 0.0           (Y)=   3.99 (T)=   3.99 (YZ)=   0.0     (MATRIX)=  1.473
           0.        0.      700.  (XY)= 0.0          (XY)=   1.95(LT)=   1.95
 2      9195.     7796.     6850.   (X)= 0.0           (X)=  57.10 (L)= 106.31 (XZ)=   0.0     (FIBER)=  0.806
         7796.     9196.     6850.   (Y)= 0.0           (Y)=  53.20 (T)=   3.99 (YZ)=   0.0     (MATRIX)=  1.473
         6850.     6850.     7925.  (XY)= 0.0          (XY)=  51.16(LT)=  -1.95
 3      9196.     7796.    -6850.   (X)= 0.0           (X)=  18.92 (L)=  23.95 (XZ)=   0.0     (FIBER)=  7.017
         7796.     9195.    -6850.   (Y)= 0.0           (Y)=  15.01 (T)=   9.98 (YZ)=   0.0     (MATRIX)=  0.033
        -6850.    -6850.     7925.  (XY)= 0.0          (XY)=  -6.98(LT)=   1.95
 4      2721.      571.       -0.   (X)= 0.0           (X)=   9.98 (L)=  23.95 (XZ)=   0.0     (FIBER)=  7.017
          571.    30120.        0.   (Y)= 0.0           (Y)=  23.95 (T)=   9.99 (YZ)=   0.0     (MATRIX)=  0.033
           -0.        0.      700.  (XY)= 0.0          (XY)=   1.95(LT)=  -1.95
```

Figure 42. Example AC-3R Problem Output

gravity data will be calculated from these drawings. The nose gear component weights will also be broken down by material types to develop a material breakdown for support of the cost model. The weight data will involve the basic weight parameters of volume displacement and material density.

The weight data necessary for the plots will be obtained by using the baseline weights of the B-1 metallic components and calculated composite hardware weights. The difference will give the total weight reduction. The estimated weight reduction will be calculated using the weight of the structural moving hardware components; forward and aft drag braces, forward and aft down lock links, torque links strut, piston axle and wheel. In addition, certain other items will change in Concept 3 and therefore must be included in the total weight. They are; new actuators, steering system and nitrogen and oil charges.

5.5 FABRICATION

During the Phase II effort, manufacturing specialists will make a tooling and fabrication study, in depth, of the concepts selected during Phase I for preliminary design. Studies will include: simplification of parts for lower cost fabrication, alternate tooling concepts for lower cost and conceptual manufacturing technology development for better producibility.

Conferences will be held during the preliminary design stage with all disciplines involved to assure that as the design progresses, producibility will receive necessary consideration. All preliminary design drawings will be checked prior to release.

A complete tooling and fabrication plan will be developed for each design. It will specify what tooling is required for each fabrication step, and what manufacturing processes will be used to make each part. Estimated hours for both tooling and fabrication will be provided for cost estimates of the parts.

5.6 COST

The Phase II preliminary designs of composite parts and the baseline metal parts will be subjected to a detailed cost analysis. Hardware cost data for the concepts selected for Phase II will be "grass roots" estimates by manufacturing experts. These estimates will be compared to standards which are being established for the B-1 program. Variance between estimates and standards will be reconciled. The standards are being developed from the test specimens and production hardware currently under contract (vertical stabilizer, weapons bay doors, stub box, etc.). Information from the composite material suppliers and the manufacturers of composite structures is

being evaluated to supplement our data. Our current composite programs are being continuously scrutinized for the purpose of developing learning curve trends for production quantities. Composite material estimates will be based on projections provided by the suppliers. Those items not selected to utilize composite materials will be evaluated on current cost or estimated based on corporate standards and projected for production quantities. The cost data for each of the composite parts and for the comparison baseline metal parts will be presented on forms similar to figures 43 and 44 and will be compared against quantity using curves similar to figure 45.

5.7 RELIABILITY

The hardware reliability analysis will utilize a serial computer math model. Table XIII presents an example of the format and output data of the hardware reliability analysis.

Explanation of Output Data:

WUC Number - Work Unit Code Number

MEL Number - B-1 Master Equipment List Number

Nomenclature - Description of Component(s) Represented by WUC/MEL Number

MTBCMA - Mean Time Between Corrective Maintenance Action

MTBCMA = 1.0/Hardware Rate (Hour Rate)

Hdwr. Rate = Corrective Maintenance Action Rate (Per 10^6 Flight Hours)

QPA - Quantity Per Aircraft

UF - Utilization Factor (Multiplying Factor to Account for Components with Excessive Ground Operating Time)

$$\text{TOTAL MTBCMA} = \frac{1.0}{\text{HDWR RATE X QPA X UF}}$$

Percent Contrib. - Percent Contribution of the Individual WUC (Component) to the Total Subsystem MTBCMA

Cum Percent - Cummulative Percent Contribution of the WUC's (Components)

•011166911
120274 0004

CONTRACT QUANTITY	RELEASE QUANTITY	QUANTITY PER SHIP	ANALYST	REQUESTED BY	DEPT	DATE	MODEL
PROD.	12.	1.	TIHACEK	L.ASCANI	421	12-3-74	

PART NAME	QUANTITY PER ASSY	UNIT COST	UNIT WEIGHT	COST PER POUND	COST PER	PERCENT COST OF ASSEM.
TI FGD ASSEM	1.	9513.29	81.100	117.30		100.00

MATERIAL COST =	3293.08	COST PER POUND =	40.61	PER CENT OF TOTAL =	34.62
FABRICATION COST =	5765.05	COST PER POUND =	71.09	PER CENT OF TOTAL =	60.60
TOOLING COST =	455.17	COST PER POUND =	5.61	PER CENT OF TOTAL =	4.78
PURCHASED LABOR COST=		COST PER POUND =		PER CENT OF TOTAL =	
Q AND R A COST =		COST PER POUND =		PER CENT OF TOTAL =	

TOTAL COST OF ASSEMBLY = $9513.29
TOTAL COST PER POUND OF ASSEMBLY = 117.30

TOTAL WEIGHT OF ASSEMBLY = 81.10

COSTS SHOWN PROVIDE A RELATIVE COMPARISON OF CONCEPTS FOR DESIGN EVALUATION. THESE COSTS DO NOT INCLUDE ALL ELEMENTS REQUIRED FOR PRICING. ESTIMATES FOR FACILITIES, EQUIPMENT, RESEARCH, DEVELOPMENT, TEST, AND ENGINEERING ARE NOT INCLUDED.

Figure 43. Summary of Dash-Numbered Parts in Concept No.1 - Tl FGD Concept L3400008

*0111E5611
120274 0303

CONTRACT QUANTITY	RELEASE QUANTITY	QUANTITY PER SHIP	ANALYST	REQUESTED BY	DEPT	DATE	MODEL
PROD.	12.	1.	TIHACEK	L. ASCANI	421	12-3-74	

PART NAME	QUANTITY PER ASSY	UNIT COST	UNIT WEIGHT	COST PER POUND	COST PER	PERCENT COST OF ASSEM.
GR/EP COMPOS ASSY L340000B	1.	7500.10	39.400	190.36		100.00

MATERIAL COST =	3299.27	COST PER POUND =	83.74	PER CENT OF TOTAL =	43.93
FABRICATION COST =	3301.49	COST PER POUND =	83.79	PER CENT OF TOTAL =	44.02
TOOLING COST =	899.34	COST PER POUND =	22.83	PER CENT OF TOTAL =	11.99
PURCHASED LABOR COST =		COST PER POUND =		PER CENT OF TOTAL =	
Q AND R A COST =		COST PER POUND =		PER CENT OF TOTAL =	

TOTAL COST OF ASSEMBLY = $ 7500.10
TOTAL COST PER POUND OF ASSEMBLY = 190.36

TOTAL WEIGHT OF ASSEMBLY = 39.40

COSTS SHOWN PROVIDE A RELATIVE COMPARISON OF CONCEPTS FOR DESIGN EVALUATION. THESE COSTS DO NOT INCLUDE ALL ELEMENTS REQUIRED FOR PRICING. ESTIMATES FOR FACILITIES, EQUIPMENT, RESEARCH, DEVELOPMENT, TEST, AND ENGINEERING ARE NOT INCLUDED.

Figure 44. Summary of Dash-Numbered Parts in Concept No. 2 - Gr/Ep COMPOS Concept L340000B

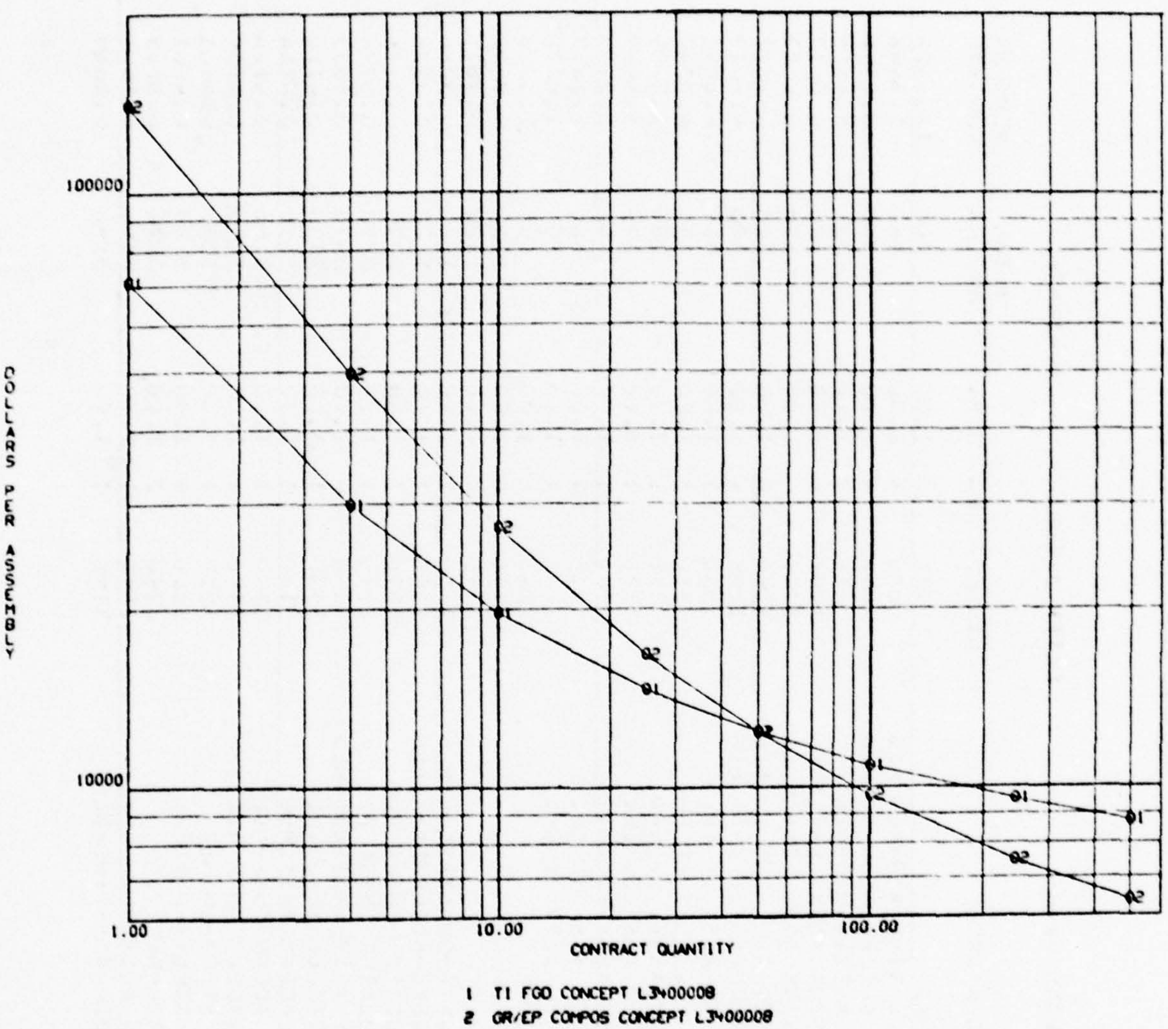


Figure 45. Effect of Quantity on Cost - DC-384 NLG Drag Brace

TABLE XIII

HARDWARE RELIABILITY RANKING

13000 LANDING GEAR CLIFF JAMES 04-16-76 PAGE 1

WUC NUMBER	MEL NUMBER	NOMENCLATURE	MTBCMA	QPA	U.F.	TOTAL MTBCMA	PERCENT CONTRIB	CUM PERCENT	RANK
13CDA9B		TIRE,MLG	770	8	1.00	160	13.6324	13.6324	1
13CDA1		WHEEL & TIRE ASSY-LH MLG	630	4	1.00	160	8.3346	21.9671	2
13CDA2		WHEEL & TIRE ASSY-RH MLG	630	4	1.00	160	8.3346	30.3017	3
13CDA		WHEEL ASSY+TIRES-NLG	470	2	1.00	230	5.6059	35.9076	4
13EAC1		HEAT SINK ASSY,BRK-LHMLG	1290	4	1.00	320	4.0017	39.9093	5
13EAC2		HEAT SINK ASSY,BRK-RHMLG	1290	4	1.00	320	4.0017	44.0311	6
13EEE1		ACTUATOR ASSY,BRK-LH MLG	1290	4	1.00	320	4.0017	48.0928	7
13EEE2		ACTUATOR ASSY,BRK-RH MLG	1290	4	1.00	320	4.0017	52.1546	8
13ACB2	AD1326	PROX. SW ASSY 20 CH.	330	1	1.00	330	4.0242	56.1787	9
13ACB3	AD1326	PROX. SW. ASSY 20 CH.	330	1	1.00	330	4.0242	60.2029	10
13ACB1	AD1326	PROX.SW ASSY. 20 CH.	350	1	1.00	350	3.7645	63.9674	11
13ACD		PROX. SW ASSY 20 CH.	370	1	1.00	370	3.5447	67.5121	12
13ACA	AD1325	PROX.SW ASSY 10 CH.	580	1	1.00	580	2.2063	69.7184	13
13ACC1		PROX. SW ASSY 10 CH.	580	1	1.00	580	2.2063	71.9246	14
13ACC2		PROX. SW ASSY 10 CH.	805	1	1.00	805	1.6272	73.5518	15
13CDA9*		WHEEL,MLG	6880	8	1.00	860	1.5226	75.1044	16
13CDA9A		WHEEL,MLG	13755	8	1.00	1720	0.7018	75.8463	17
13CDA9C		TIRE,MLG	13755	8	1.00	1720	0.7018	76.6581	18
13EEB1	AD4653	VALVE,HYD-DUALMTBK-LHMLG	1800	1	1.00	1800	0.7286	77.3867	19
13EEB2	AD4653	VALVE,HYD-DUALMTBK-RHMLG	1800	1	1.00	1800	0.7286	78.1152	20
13EEU	AD4160	ACCUMULATOR-EMERG NLG	2270	1	1.00	2270	0.5774	78.6926	21
13CEW	AD4139	ACCUMULATOR-EMERG MLG	2270	1	1.00	2270	0.5774	79.2701	22
13CDD		FILTER ASSY-ANTISKID,MLG	9360	4	1.00	2330	0.5633	79.8333	23
13EEV	AD4166	GAUGE,ACCUM PRESS,NLG	3130	1	1.00	3130	0.4186	80.2519	24
13CBZ	AD4142	GAUGE,ACCUM PRES,MLG	3130	1	1.00	3130	0.4186	80.6706	25
13EEN	AD4162	VALVE ACCUM DUMP-NLG	3150	1	1.00	3150	0.4164	81.0870	26
13CBF	AD4141	VALVE,ACCUM DUMP RELIEFM	3150	1	1.00	3150	0.4164	81.5034	27
13CAA	AC4369	SHOCK STRUT-LH MLG	3230	1	1.00	3230	0.4061	81.9095	28
13CAB	AC4369	SHOCK STRUT-RH MLG	3230	1	1.00	3230	0.4061	82.3156	29
13ELH	AD4151	ACTUATOR-NLG	6740	2	1.00	3370	0.3285	82.7041	30
13EAC	AC4105	UPLOCK ASSY-NLG	3590	1	1.00	3590	0.3649	83.0090	31
13EAD	AC4112	DOWNLOCK ASSY,FWD-NLG	3590	1	1.00	3590	0.3649	83.4339	32

Rank - WUC's (Components) are Ranked by Percent Contribution of the Total Subsystem MTBCMA

The analysis is based on each components hardware failure rate, which is a function of the component's corrective maintenance frequency, the hardware reliability approach was chosen due to the unavailability of historical operational failure data on composite components. On this basis a hardware reliability analysis based on component corrective maintenance frequencies was concluded to be more meaningful at this time.

5.8 MAINTENANCE

The preliminary design drawings will be evaluated in terms of maintenance required during the ten year support time span and the cost of this support will be estimated as an increase or decrease from the baseline costs previously reported.

The change (Δ) in support cost is given by the following equation.

Δ Support Cost = Δ Spares Cost = Δ AGE Cost + Δ Personnel Cost

A. Spares = Initial Spares + Recurring Spares + Parts & Kits
B. AGE = Cost of Special AGE for all Bases
C. Personnel = Cost of Maintenance Airmen and their Training

A-1. The "Initial Spares" costs equation is given below:

Initial Spares Costs = Maintenance Demand RAte
x Quantity/Aircraft
x Flight Hours/Month/Wing
x Turn-around Time
x Number of Wings
x Unit Cost of Spare

The change (Δ) in cost is given below.

Δ Initial Spares Cost = Initial Spares Cost (Composite)
— Initial Spares Cost (Baseline Metallic)

A-2. The "Recurring Spares" cost equation is shown below:

Quantity Recurring Spares = Maintenance Demand Rate
x Quantity per Aircraft
x Total Fleet Flying Hours
x Condemnation Factor
Cost Recurring Spares = Quantity x Unit Cost
Δ Recurring Spares Cost = Recurring Spares Cost (Composite)
— Recurring Spares Cost (Baseline)

A-3. The "Parts/Kits" cost equation is given below:

Parts/Kits Cost	= Maintenance Demand Rate x Total Fleet Flying Hours x Repair Factor x Unit Cost
Repair Factor	= F (Unit Cost & Historical Repair Data)
Δ Parts/Kits Cost	= Parts/Kits Cost (Composite) — Parts/Kits Cost (Baseline)

B. AGE costs are given by the following equation.

Δ AGE Cost	= Δ Quantity x Number of Wings x Unit Cost
Δ Quantity	= Maintenance Demand Rate x Quantity per Aircraft x Flying Hours/Month/Wing x Δ Mean Time to Repair x 1/(Operating Time x 0.9)

C. Personnel cost is given by the equation below:

Δ Personnel Cost	= Δ Maintenance Demand Rate x Quantity per Aircraft x Total Fleet Flying Hours x Cost/Productive Manhours x Maintenance Task Time

Cost per productive manhour includes efficiency, personnel types, and training of maintenance airmen.

5.9 LIFE CYCLE COST

Life cycle cost is the sum of development, production, and support costs. The assumed life cycle cost baseline will be the existing metallic design. This baseline will be compared separately with each of the proposed composite concepts and the cost deltas shown. An attempt will be made to identify all areas of cost impact. Particular attention will be paid to problems that might be encountered in field maintenance: probability of accidental damage, special tool requirements, material and training necessary for composite repair, and repair task time. Special problems that will be addressed include galvanic corrosion and wear of composite bearing surfaces. Such factors will be expressed in terms of a 10-year maintenance cost.

The affect of changes in empty weight on fuel and tanker requirements will also be evaluated. A summary of the life cycle cost evaluation will be made for each of the proposed concepts. This summary will include explanations of the major factors affecting each element of life cycle cost.

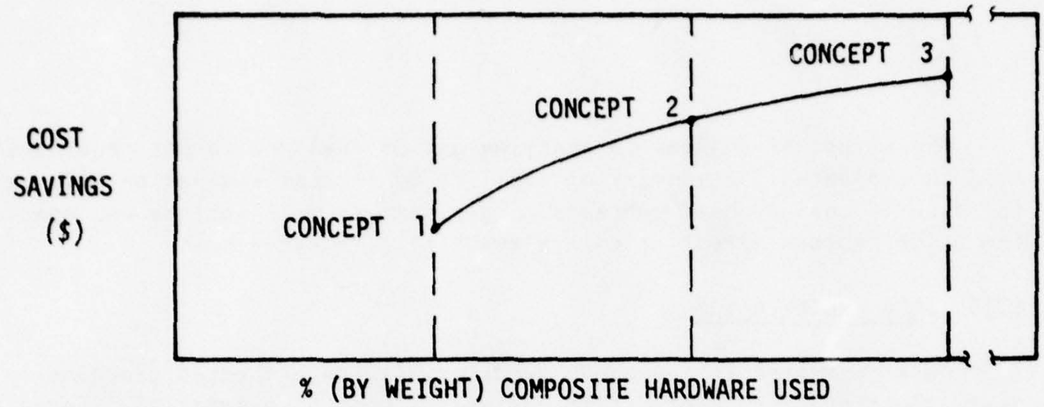
5.10 DATA PRESENTATION

Data generated in the above sections will be presented graphically to best illustrate the payoffs from the use of composite material. Three data plots will be made: initial cost savings; life cycle cost savings; and total weight reduction; all plotted against percent (by weight) of composite hardware used in the nose gear. See example in figure 46.

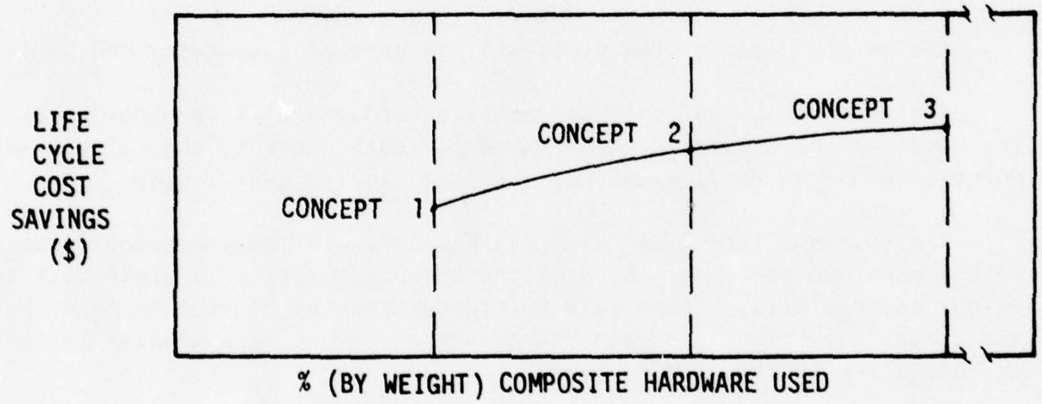
The weight data for the plots will be generated as described on page 80.

The percent (by weight) of composite hardware will be obtained by using the total weight of composite hardware for each concept, and calculating its percentage of the total weight of the nose landing gear system.

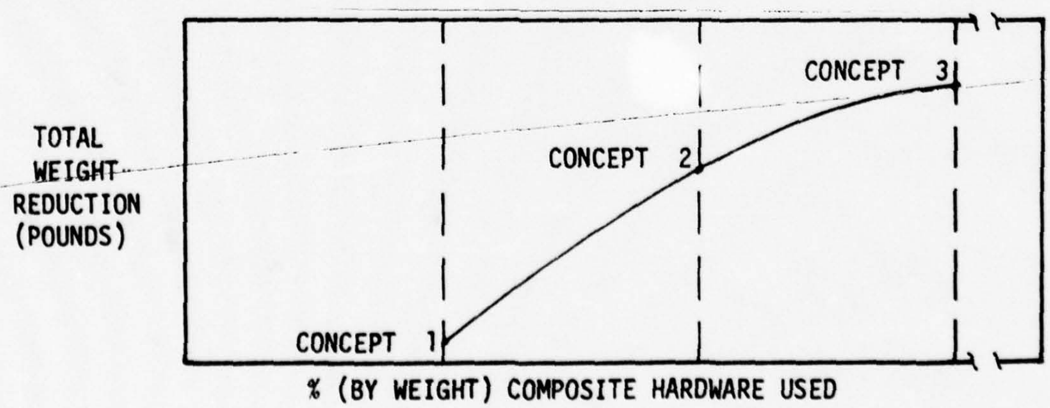
The cost and life cycle cost savings data will be generated as described in the previous sections. Each of the three concepts will yield cost and weight savings data. These data points can then be plotted on each chart and curves drawn to illustrate the advantages of using a greater percentage of composites in the landing gear.



INITIAL COST SAVINGS CHART



LIFE CYCLE COST SAVINGS CHART



TOTAL WEIGHT REDUCTION CHART

FIGURE 46 DATA PLOT EXAMPLES

SECTION VI

EVALUATION

6.1 RATING SYSTEM

Design concepts studied during Phase I have been evaluated and rated to provide a basis for selection of parts to be carried forward into Phase II for Preliminary Design and Analysis. The evaluation of these Phase I studies has been made by all disciplines concerned and the information generated has been organized into rating tables and each design studied has been rated to indicate whether it is a "good," "Moderately effective" or "marginally effective" design. Weighting factors were then assigned to each rating according to their importance in the overall system.

The baseline composite material, Graphite/Epoxy, was used in all designs and therefore was not used for rating the designs. A qualitative cost evaluation indicates that most designs could be cost effective and would result in weight savings over the baseline metallic part. A better cost estimate would require more information on tooling and manufacturing processes than could be generated in this time limited program.

6.1.1 Weighting Factor

Subratings have been given for "Fabrication," "Technical Risk" and "Weight Savings," but since all the subratings are not considered equal in their influence on the final rating of the part, a "weighting" factor has been used. This "weighting" factor has been assigned a value of 1 to 5 which indicates that the subrating has an effect on the total evaluation rating of; 1 = negligible importance, 2 = moderate importance, 3 = important, 4 = great importance, and 5 = very important.

6.1.2 Fabrication Rating

The fabrication rating indicates a consideration of manufacturing methods necessary to produce the part and whether or not they are state-of-the-art. Complexity and number of tools and fabrication time have also been considered. A rating of 1 to 3 points has been used with; 1 = good, 2 = moderate, and 3 = marginal producibility. A weighting factor of 2 has been used indicating "moderate importance."

6.1.3 Technical Risk

Technical risk is a very important consideration and indicates the estimated structural adequacy of a part built to the design concept studied.

It is based on a consideration of:

1. Assmptions necessary for analysis
2. State-of-the-art of the analysis required.
3. Load Paths
4. Stress concentrations, and
5. Stiffness changes

A rating of 1 to 4 points has been used with 1 = low, 2 = moderate, 3 = high, and 4 = very high risk design. A "very high risk" design will not be selected for further design effort in Phase II. A weighting factor of 5 has been used, indicating "very great importance."

6.1.4 Weight Savings

Weight saving ratings are based on the estimated weight saved when compared to the baseline part. A rating of 1 to 3 points has been used with: 1 = high, 2 = moderate, and 3 = low or no weight savings on the part. A weighting factor of 3 has been used indicating "important."

6.1.5 *Evaluation Rating*

Each of the design in all concepts have been rated and the rating (a) and weighted ratings (b) have been entered as a/b in the columns in Tables XIV, XV, XVI, XVII, and XVIII. The "evaluation" rating is the sum of all the weighted subratings, (b), and could have a range of values from 10 to 35. The values indicate the rating of the design concept as:

a) 10-20 = good design
b) 21-30 = moderately effective design
c) 31-35 = marginal design

Designs rated "marginal" have not been selected for preliminary design effort in Phase II.

6.2 CONCEPT 1 - SUBSTITUTION

Concept 1 - Substitution design, see figure 25-31, was constrained by "form, fit and function." See Table XIV for rating of the designs.

TABLE XIV

PHASE 1 CONCEPT 1 "SUBSTITUTION"

CONCEPT EVALUATION CHART

DESIGN CONCEPT	I FABRICATION RATING *WF = 2	II TECHNICAL RISK WF = 5	III WEIGHT SAVINGS WF = 3	IV EVALUATION RATING I+II+III
Drag Brace - Fwd.	**2/4	2/10	3/9	23
Drag Brace - Aft	3/6	2/10	3/9	25
Down Lock - Fwd.	3/6	3/15	3/9	30
Down Lock - Aft	2/4	3/15	3/9	28
Torque Link	2/4	4/20	3/9	33
Strut-Trunnion Arms-A	3/6	4/20	3/9	35
Strut Trunnion Arms-B	2/4	3/15	3/9	28
Wheels	3/6	3/15	2/6	27

*W.F. = Weighting Factor

** 2/4 = 2 (Rating) X 2 (Weighting Factor) = 4 (Weighted Rating)

The "very high technical risk" rating given to the designs for the "Torque Links" and "Strut-Trunnion Arms-A" eliminate these designs from further effort in Phase II of this program. "Weight Savings" ratings indicate that "Substitution" parts will not be weight effective.

"Substitution" designs, all rated "moderately effective design," and recommended for further effort in Phase II include:

1. Drag Brace - Fwd.
2. Drag Brace - Aft
3. Down Lock - Fwd.
4. Down Lock - Aft
5. Strut - Trunnion Arms-B
6. Wheels

6.3 CONCEPT 2 - MODIFICATION

Concept 2 - Modified design was constrained by "fit and function". Two versions, Concept 2-A and Concept 2-B were produced and are rated separately.

Concept 2-A, see figure 32, is rated in Table XV .

TABLE XV

PHASE 1 CONCEPT 2-A "MODIFIED

CONCEPT EVALUATION CHART

	I	II	III	IV
DESIGN CONCEPT	FABRICATION RATING *WF = 2	TECHNICAL RISK WF - 5	WEIGHT SAVINGS WF - 3	EVALUATION RATING I+II+III
Drag Brace - Fwd.	2/4	3/15	1/3	22
Drag Brace - Aft	2/4	2/10	1/3	17
Spreader Bar-(Drag Brace)	2/4	2/10	3/9	23
Down Lock - Fwd.	2/4	3/15	3/9	28
Down Lock - Aft	2/4	3/15	3/9	28
Torque Link	2/4	4/20	3/9	33
Strut-Trunnion Arms	3/6	3/15	2/6	27
Wheel	3/6	3/15	1/3	24

*W.F. = Weighting Factor

The "Torque Links" were again eliminated from further effort in Phase II by a "very high technical risk" rating.

Concept 2-B, see figure 33, is rated in Table XVI.

TABLE XVI

PHASE 1 CONCEPT 2-B "MODIFIED"

CONCEPT EVALUATION CHART

	I	II	III	IV
DESIGN CONCEPT	FABRICATION RATING *W.F. = 2	TECHNICAL RISK W.F. = 5	WEIGHT SAVINGS W.F. = 3	EVALUATION RATING I+II+III
Drag Brace - Fwd.	3/6	2/10	1/3	19
Drag Brace - Aft	2/4	2/10	1/3	17
Spreader Bar - (Drag Brace)	2/4	2/10	3/9	23
Down Lock - Fwd.	2/4	3/15	3/9	28
Down Lock - Aft	2/4	3/15	3/9	28
Torque Link	2/4	3/15	3/9	28
Strut-Trunnion Arms	3/6	3/15	3/9	30
Wheel (Same as 2-A)	3/6	3/15	1/3	24

*W.F. = Weighting Factor

Kinematics on both Concept 2-A and 2-B is the same, so designs from either study have been recommended for the Concept 2 effort in Phase II, based on their respective evaluations.

"Modified" designs recommended for further effort in Phase II include:

1. Drag Brace - Fwd. - Concept 2-B - rated "good design" and selected on the basis of lower technical risk.

2. Drag Brace - Aft - Concept 2-A - rated "good design" and is the same design as 2-B

3. Spreader Bar - Concept 2-B - rated "moderately effective design" mates with 2-B drag brace and ratings are the same as 2-A

4. Down Lock - Fwd. - Concpet 2-A - rated "moderately effective design" and 2-B is same design

5. Down Lock - Aft - Concept 2-A - same as above

6. Torque Link - Concept 2-B - rated "moderately effective design" and Concept 2-A was a very high technical risk design

7. Strut - Trunnion Arms - Concept 2-A - rated "moderately effective design" and selected on the basis of being more weight effective

8. Wheels - Concept 2 - design on figure 31 is rated as "moderately effective design"

6.4 CONCEPT 3 - REDESIGN

Concept 3 "redesign" studies were constrained by function only. Two studies were made for this concept, concept 3-A and 3-B, and they have been rated separately.

Concept 3-A, see figure 36, is rated in Table XVII.

Concept 3-B, see figure 37, is rated in Table XVIII.

TABLE XVII

PHASE 1 CONCEPT 3-A "REDESIGNED"

CONCEPT EVALUATION CHART

DESIGN CONCEPT	I FABRICATION RATING *W.F. = 2	II TECHNICAL RISK W.F. = 5	III WEIGHT SAVINGS W.F. = 3	IV EVALUATION RATING I+II+III
Drag Brace - Fwd.	2/4	3/15	1/3	22
Drag Brace - Aft	2/4	3/15	1/3	22
Spreader Bar (Drag Brace)	2/4	3/15	1/3	22
Down Lock - Fwd.	2/4	3/15	3/9	28
Down Lock - Aft	2/4	3/15	3/9	28
Torque Link	2/4	3/15	3/9	28
Strut - Complete (cylinder & trunnion arms)	3/6	3/15	1/3	24
Piston	3/6	4/20	2/6	32
Axle	2/4	3/15	2/6	25
Wheel	3/6	3/15	3/9	30

* W.F. = Weighting Factor

The "Piston" design was rated as a "very high technical risk" and therefore is not recommended for further effort in Phase II.

TABLE XVIII

PHASE 1 CONCEPT 3-B "REDESIGNED"

CONCEPT EVALUATION CHART

DESIGN CONCEPT	I FABRICATION RATING *W.F. = 2	II TECHNICAL RISK W.F. = 5	III WEIGHT SAVINGS W.F.= 3	IV EVALUATION RATING I+II+III
Drag Brace - Fwd. (structural concept)	3/6	2/10	1/3	19
Drag Brace - Aft (structural concept)	3/6	2/10	1/3	19
Spreader Bar (drag brace-3-A)	2/4	3/15	1/3	22
Down Lock - Fwd. (same as 3-A)	2/4	3/15	3/9	28
Down Lock - Aft (same as 3-A)	2/4	3/15	3/9	28
Strut - Complete	3/6	3/15	3/9	30
Stem (rotating)	2/4	3/15	3/9	28
Trailing Arm	2/4	4/20	3/9	33
Axle	2/4	3/15	2/6	25
Wheel (same as 3-A)	3/6	3/15	3/9	30

*W.F.- Weighting Factor

The "Trailing Arm" design was eliminated from further effort in Phase II since it was rated as a very high risk design.

Both Concept 3-A and 3-B require a larger nose wheel well, but the change required to accommodate the 3-A concept is slight, while a more extensive revision would be required for the 3-B concept. In addition, concept 3-A is more weight effective; therefore, it has been selected as the "redesigned" study to be carried into Phase II, but since the drag links are similar, the structural concept for axially loaded struts of concept 3-B will be used.

"Redesigned" part concepts recommended for further effort in Phase II include:

1. Drag Brace - Fwd. - Concept 3-B - rated "good design" and selected on the basis of lower technical risk.

2. Drag Brace - Aft - Concept 3-B - rated "good design" and selected on the basis of lower technical risk.

The following are all rated as "moderately effective design."

3. Spreader Bar - Concept 3-A and 3-B are same design

4. Down Lock - Fwd. - Concept 3-A and 3-B are same design

5. Down Lock - Aft - Concept 3-A and 3-B are same design

6. Torque Links - Concept 3-A required for 3-A concept

7. Strut - Complete - Concept 3-A more weight effective

8. Axle - Concept 3-A required for 3-A concept

9. Wheel - Concept 3-A no 3-B wheel concept

SECTION VII

CONCLUSIONS

The following conclusions were reached as a result of work done on Phase I of this two-phase program:

1. The B-1 nose landing gear is well suited to use as a baseline system.

2. Baseline requirements and constraints for the B-1 nose landing gear present no major obstacle to the use of composite material hardware.

3. More design, analysis and evaluation effort must be expended before firm statements can be made as to the expected results of this program.

4. Designs using composite material for landing gear hardware are considered to be practical under all three levels of constraint: form, fit and function; fit and function; and function only.

5. Usage of composite material for landing gear hardware can be increased as design freedom is increased.

6. Methodology to provide and evaluate data necessary to illustrate the pay-offs from the use of composite material hardware either exists or has been developed during this phase.

REFERENCES

1. Advanced Composite Design Guide, Volume II, Third Edition, prepared for AFML by Rockwell International, Los Angeles Aircraft Division, January 1973.

2. Ascani, L., "Preliminary Design and Analysis of an Advanced Composite Wing Pivot Structure," Volume III, Part I, AFFDL-TR-74-2, March 1974.

3. AFML-TR-74-5, "Advanced Composite Wing and Empennage to Fuselage Attachment Fittings," Contract F33615-71-C-1587. Prepared by General Dynamics/Convair Aerospace Division, Schaefer, W. H., et. al.., for Air Force Materials Laboratory, January 1974.

4. AFFDL-TR-73-69, "Graphite Composite Landing Gear Components - Side Brace Assembly and Torque Link for A37B Aircraft," Contract F33615-71-C-1508, prepared by Hercules Incoporated for Air Force Flight Dynamics Laboratory, May 1973.

5. NA-72-1, "Structures Manual," prepared by Rockwell International, B-1 Division.

6. "Graphite Composite Aircraft Landing Gear Wheel," Air Force Contract F33615-74-C-3040, prepared by Hercules Incoporated for the Air Force Flight Dynamics Laboratory.

7. Phase II Report, "Graphite Composite Landing Gear Component," Contract F33615-72-C-1725.

8. AFFDL-TM-74-199-FEM, "Wear and Pressure Testing of an Unlined Graphite/ Epoxy Cylinder Subjected to Landing Gear Test Conditions," prepared by Mechanical Branch, Vehicle Equipment Division, AFFDL, WPAFB; Shumaker, Gerald C., Capt. USAF.

APPENDIX B

DESIGN REQUIREMENTS

APPENDIX B

DESIGN REQUIREMENTS

The B-1 Prime Item Development Specification (CP109L2001B) lists the following design requirements.

A. CHARACTERISTICS

1. Performance: Performance of the landing gear system (LGS) shall permit accomplishment of the air vehicle performance specified in the paragraphs entitled "Flotation, Landing and Takeoff" of CP621L2002 and "Structural Criteria" of CP621L2003 as modified by Appendix III, hereto, for MLG wheels, tires and brakes. The LGS shall provide the following functions:

a. Absorb and/or transmit the static and dynamic energy resulting from the air vehicle takeoff, landing, and ground maneuvering operations.

b. Provide directional control to accomplish steering, turning, pivoting, taxiing, and braking of the air vehicle.

c. Provide ground flotation for the air vehicle during ground maneuvers.

d. Provide for retraction, extension and locking of the main and nose gears for the flight and ground mode of operation, and indication and warning to the pilot of gear position.

e. Provide for towing, tie-down, and wheel jacking.

2. Landing Gear Operation The main and nose landing gear assemblies shall be hydraulically operated and electrically controlled. Gear position shall be selected by means of the landing gear control handle located in the flight station. Sequencing shall be accomplished by use of switches, relays, solenoid and/or mechanically operated valves. Protection against inadvertent retraction of the landing gear with the air vehicle on the ground shall be provided.

3. Retraction and Extension The main and nose landing gears shall be fully retractable and completely enclosed when in the retracted position. The gears shall automatically lock in the extended and retracted position by means of positive mechanical locks. Locking the gears in either the extended or retracted position shall not be dependent upon hydraulic pressure. The locks

shall be designed such that they shall release the gears prior to or at the same instant the gear extension actuator receives hydraulic pressure. The main nose gear doors and gear uplock mechanisms shall be unlocked by hydraulic power. Fairings and closures shall be designed with adequate clearance considering flat tire and flat strut conditions. Interruption of the control sequence or driving power to the landing gear and fairing door actuation system during normal or emergency operation shall not result in system malfunction or structural damage to any part of the air vehicle. The landing gear and fairing doors shall continue to the selected position upon reapplication of hydraulic power.

4. Retraction and Extension Time Retraction and extension time for the main and nose landing gear and door assemblies shall be as shown in Table B-1. The main and nose landing gears shall be retracted and locked before the air vehicle reaches 75 percent of the gear structural design limit speed (V_{LF}) at the maximum rate of acceleration.

TABLE B-1

RETRACTION AND EXTENSION TIME

Item	Temperature	Maximum Allowable Time to Open Doors and Extend and Lock Gears	Maximum Allowable Time to Retract and Lock Gears and Doors
a	Above minus 20 F	15 Seconds	15 Seconds
b	Minus 65 F to minus 20 F	30 Seconds	30 Seconds

5. Structural Design Speeds The main and nose landing gears shall be designed to withstand air loads resulting from speeds up to 340 knots equivalent air speeds (EAS) for all extension positions to full extension, and shall be capable of operating (retraction and extension) at speeds up to 280 knotts EAS. Actuators and linkages shall be designed to withstand the loads imposed by these design operating conditions, including the effects of hydraulic surges and pressures.

6. <u>Emergency Gear Operation</u> An emergency extension control shall be provided that is independent of the normal gear operating controls. It shall be possible to extend the landing gear to the down and locked position in the event of any single hydraulic or electrical component failure. The landing gear shall be capable of emergency extension to a down and locked position, independent of the air vehicle hydraulic and electrical power generation subsystems. Primary means of emergency operating power shall not be dependent upon battery power. Emergency extension time shall not be greater than twice the maximum allowable operating limits specified in Table B-1.

7. <u>Free Fall Capability</u> After uplock relase, the nose gear shall have the capability of free fall extension and lock. Free fall extension and lock of the main gear shall be a design goal, with the assistance of spring bungees and/or stored hydraulic energy as required to assure safe operation.

8. <u>Jacking</u> Wheel jacking provisions shall be incorporated in accordance with MIL-STD-809.

9. <u>Towing</u> Towing provisions shall be incorporated in accordance with MIL-STD-805.

10. <u>Attachment Provisions</u> Provisions shall be made for attachment, routing, and protection of electrical wire, switches, door operating linkages, valves, nameplates, and hydraulic lines.

11. <u>Mooring Provisions</u> The nose gear shock strut shall incorporate mooring lugs for tie-down of the air vehicle.

12. <u>Protection from Damage</u> The effects of rocks, ice and other foreign object damage shall be considered in the design and installation of hydraulic lines and components.

13. <u>Spare Strut Piston Seals</u> Provisions shall be incorporated in the design of the lower bearing and glad to carry spare seals as replacements for the lower piston seal.

B. RELIABILITY

The LGS shall incorporate those design characteristics essential to the achievement of the quantitative and qualitative reliability requirements specified for the air vehicle.

C. MAINTAINABILITY

1. Quantitative Maintainability The LGS shall incoporate those design characteristics essential to the achievement of the quantitative maintainability requirements specified for the air vehicle.

2. Qualitative Maintainability The standard Air Force policy of three levels of maintenance (organizational, intermediate and depot) shall be employed for the LGS. The following qualitative requirements shall apply.

3. General

a. The LGS shall be self-sufficient to the extent of permitting preflight inspections to be performed without prepositioned AGE, and permitting postflight inspections to be performed without prepositioned AGE, except for step ladders or workstands, and ground safety locks/devices.

b. The LGS shall permit all maintenance to be accomplished by Air Force technicians 5 skill level maintenance personnel, with occasional 7 skill level personnel, using existing Air Force facilities and for most tasks, existing AGE. Design for repair by Air Force technician 3 skill level maintenance personnel shall be a goal.

c. Equipment design shall reflect thorough consideration of the capabilities of human resources available to maintain the equipment and the utilization of automatic test equipment to support maintenance personnel.

D. MAJOR COMPONENT CHARACTERISTICS

1. Shock Struts - General The main and nose landing gear shock strut shall comply with the requirements of MIL-L-8552, MIL-T-6053, AFSC DH 2-1, and the engineering critical item development specifications. The shock struts shall be designed such that the passage of oil through an orifice shall absorb the energy of impact and in which dry nitorgen is used as the elastic medium to restore the unsprung parts to their extended position. The shock struts shall be capable of withstanding the loads derived from MIL-A-8860, MIL-A-8862, MIL-A-8866, MIL-A-8867, and the load conditions specified in CP621L2002 and CP621L2003, including static strength and four lifetime fatigue requirements. The air vehicle design sinking speed shall be 10 feet per second at the target landplane landing design weight and 8 feet per second at the target maximum design landing weight. The shock

struts shall be capable of supporting the air vehicle on a flat strut (loss of nitrogen) through the complete landing cycle, at normal landing conditions, without damage to the shock struts or carry-through structure. A complete landing cycle at normal landing conditions shall consist of landing at a landplane landing design target weight at a sink speed of 8 feet per second. The landing runout and taxi design load for the flat strut condition shall be the static gear load at maximum taxi weight times a dynamic factor of 1.2. Compression ratios shall be compatible with all applicable LGS design and performance requirements.

2. Nose Gear Shock Strut The nose gear shock strut shall be of the conventional air-oil piston type with provisions for mounting twin free rotating wheels on a fixed axle. The shock strut shall withstand the loads induced by the steering and damping unit.

3. Stroke The nose gear shock strut shall have a design vertical stroke of 21 inches measured at the axle centerline and a design 7-inch stroke from the static to compressed position.

4. Torsional Spring Rate The torsional spring rate of the nose gear shock strut, in the static position, shall not exceed 1.4×10^{-4} radians per 1000 inch-pounds.

5. Swivel Angle The nose gear shock strut shall alllow the nose wheels to caster through 360 degrees rotation without requiring mechanical disconnect.

6. Nose Wheel Centering The nose gear shock strut shall be capable of centering the nose wheels, prior to retraction, to within plus or minus 0.25 degree of center.

7. Interface Compatibility The nose gear shock strut shall be designed for interface compatibility with the following:

a. Nose wheel assembly.

b. Tire (see figure B-1 for tire clearance envelope dimensions).

c. Steering and damping unit, including all fittings and mountings required to route hydraulic lines.

d. Air vehicle structure. The air vehicle structure shall provide adequate space to permit retraction and extension of the nose gear assembly without inerference or blinding. The doors shall operate propertly without interfering with the retract/extend cycle of the nose gear. Attachment provisions shall be provided to reduce the tendencies of gear shimmy.

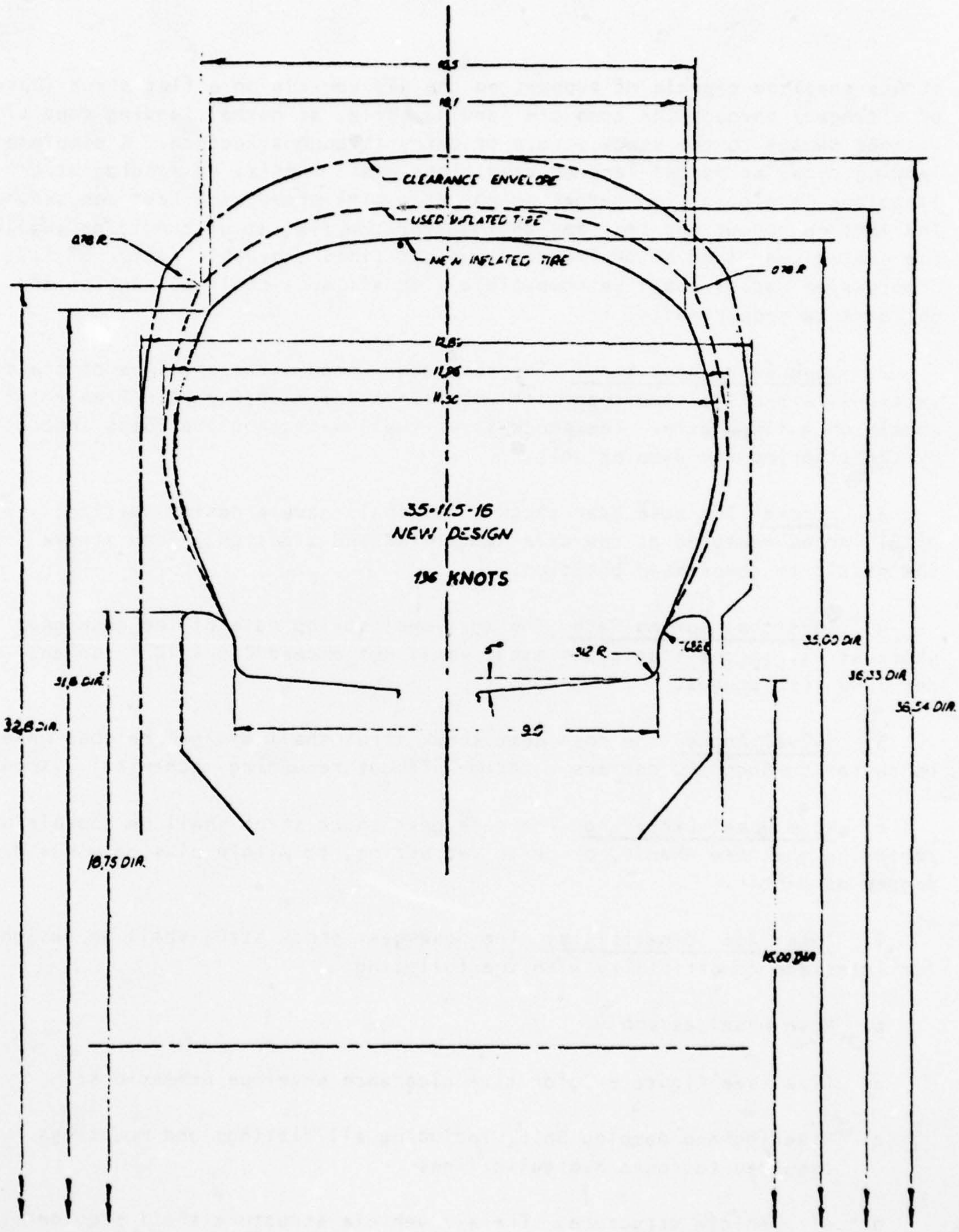


Figure B-1 Nose Gear Tire Clearance Envelope

E. WHEEL ASSEMBLIES - GENERAL

The main and nose landing gear wheel assemblies shall comply with the requirements specified in the engineering critical item development specifications and MIL-W-5013, except the wheels shall be capable of being rolled a distance of 2500 miles, including consideration for combined radial and side loads corresponding to those produced by 0.25g turns.

1. Overpressure Relief Valve A pressure relief valve shall be provided for the wheel to prevent overpressurization of thewheel and tire assembly.

2. Tire Change Counter. Provisions shall be incorporated in each wheel for recording a minimum of 50 tire changes.

3. Tire Pressure Gage A tire pressure gage shall be incorporated on the outboard side of the wheel assembly. The gage shall conform to MIL-G-83016, except the gage shall withstand exposure to vibration and to a burst pressure of 625 psi.

F. NOSE GEAR WHEEL ASSEMBLY

1. Structural Loads The nose gear wheel assembly shall be capable of withstanding the structural loads resulting from air vehicle takeoff, landing and ground maneuvering operations.

2. Interface Compatibility The nose gear wheel assembly shall be designed for interface compatibility with the nose landing gear shock strut and for installation of a tubeless tire in accordance with figure B-1. Stops shall be provided in the nose gear wheel well to prevent rotation of the nose wheel after completion of the retraction cycle. The physical interface shall be as defined in the engineering critical item development specification.

G. STEERING AND DAMPING SUBSYSTEM

The steering and damping subsystem shall comply with the requirements of MIL-S-8812, AFSC DH 2-1, and the engineering critical item development specification. The steering and damping subsystem shall provide electrically controlled, hydraulically powered angular displacement of the nose landing gear wheels to permit directional control of the air vehicle during ground maneuvers, including taxi, takeoff, and landing operations. In addition, the subsystem shall provide effective shimmy damping to assure dynamic stability of the nose landing gear under all ground operating conditions.

1. <u>Swivel Range</u> The steering and damping subsystem shall allow the nose wheel to caster through 360-degree rotation without requiring mechanical disconnects or lost motion cam mechanisms. Loss of steering power shall result in the nose wheels being capable of returning to a neutral or safe position. The nose wheels shall caster in a safe trail position, with damping after loss of power and shall be capable of free caster to within the powered steering range, from any parked position, with forward motion of the air vehicle.

APPENDIX C

EXTERNAL LOADS

APPENDIX C

EXTERNAL LOADS

The following pages present a summary of nose gear loads for the B-1 A/V #4 from the B-1 System Definition Manual.

Included are:

1. Landing, Taxi, and Handling Loads
2. Dual Wheel Load Distribution
3. Ultimate Load Determination
4. Fuselage Support Structure Deflections
5. Temperature Condition
6. Drop Test Requirements
7. Actuation System Loads
8. Nose Gear Uplock Loads
9. Nose Gear Door Link Loads
10. Nose Gear Steering Torque
11. Repeated Loads Design Requirements
12. Nose Landing Gear Support Reactions

NOSE GEAR LOADS

(Reference L287C2037, dated 30 January 1976)

1. LANDING, TAXI, AND HANDLING LOADS

Tables C-I, C-II, C-III, and C-IV define the loads attendant to the landing, taxi, and handling conditions.

TABLE C-I

LANDING WEIGHTS AND SINK SPEEDS

Item	Landing Condition	Weight	Sink Speed (V_s) (fps)
a	Landplane landing weight	263,330	10
b	Maximum landing weight	346,500	8
c	Minimum landing weight	161,700	10
d	Flat strut landing weight	263,330	8

TABLE C-II

NOSE GEAR "DESIGN" DYNAMIC LANDING LOADS

Item	Landing Condition	V (Parallel to Strut)	D (Perpendicular to Strut)
a	Spinup (SU)	61,100	47,000
b	Springback (SB)	98,500	-42,000
c	Maximum vertical reaction (MVR)	98,500	+24,600, -42,000

TABLE C-III
NOSE GEAR "LIMIT" TAXING LOADS FOR
W TAXI = 395,000 POUNDS

Item	Taxi Conditions	V (Parallel to Strut)	D (Perpendicular to Strut)	S (Side Load)
a	Three-point braked roll	85,296	---	---
b	Unsymmetrical Braking	61,621	---	±16,814
c	Turning	34,027	---	±13,611
d	Dynamic taxi	93,500	---	---

TABLE C-IV
NOSE GEAR HANDLING LIMIT LOADS
PARALLEL AND PERPENDICULAR TO GROUND
FOR W TAXI - 395,000 POUNDS

Item	Condition	V (Parallel to Strut)	D (Perpendicular to Strut)
a	Static reactions:		
	WL normal = 263,300	36,630	0
	WL maximum = 346,500	39,150	0
	WL minimum = 161,700	18,270	0
	W taxi = 395,000	34,027	0
b	Towing	34,027	Ft maximum - 59,250
c	Jacking (side load = ±15,910	53,710	±15,910

General Notes.

a. Sign Convention.

(1) +V is up
(2) +D is aft
(3) +S is to right

b. Landing Conditions.

(1) SU, SB, and MVR loads act perpendicular and parallel to the strut centerline and are applied at the centerline of the axle.

(2) Strut is extended a maximum of 85 percent at design load; tires are static.

c. Taxi and Handling Conditions.

(1) All loads are perpendicular and parallel to the ground line and are applied at the ground contact point. (See Figure C-1).

(2) The strut is in the static position corresponding to the airplane weight being considered.

(3) Tires are static.

d. Handling Conditions. Towing and jacking load combinations shall be in accordance with MIL-A-8862.

e. Secondary Loads. The load analysis shall include the effects of elastic deflections.

f. Actuation Loads. Effects of actuating cylinder loads shall be considered when critical and applicable.

g. Side Loads. Side loads should be distributed to the trunnion support fitting using a 60/40 distribution. In addition, induced equal and opposite side loads equal to 15 percent of the total (left-hand and right-hand) vertical trunnion load shall be applied in the inboard direction to the trunnion if such a load combination is critical.

h. For taxi and ground handling load conditions at W taxi = 395,000 pounds, the definition of ultimate shall be 1.5 times the limit external load applied at limit load deflections.

2. DUAL WHEEL LOAD DISTRIBUTION

The nose landing gear loads specified herein shall be distributed to the respective wheels noted on Figure C-1 as follows:

a. Symmetrical Load Distribution. Landing gear loads shall be equally distributed to each wheel.

b. Unsymmetrical Load Distribution. The following conditions need not be considered for unsymmetrical load distribution:

(1) Unsymmetrical Braking.

(a) Unequal Tire Pressure Conditions. Individual wheel loads shall be as follows: (See Figure C-I)

Case	NL	NR
A	60.0	40.0
B	40.0	60.0

Where the above values are percents of design or limit load. For the turning condition, side load to the right, 60 percent need not be considered on the right wheel. For side load to the left, 60 percent need not be considered on the left wheel.

(b) Flat Tire Conditions. Individual wheel loads shall be as follows: (See Figure C-I).

Case	NL	NR
A	1.00	0
B	0	1.00

Where the above values are to be used with 60 percent of the specified gear load for landing conditions and 50 percent for taxi conditions, except:

The reaction shall not be less than static.

For three-point braked roll use V load = 64,150 pounds limit.

AD-A058 672 ROCKWELL INTERNATIONAL LOS ANGELES CALIF LOS ANGELE--ETC F/G 11/4
NEW CONCEPTS IN COMPOSITE MATERIAL LANDING GEAR FOR MILITARY AI--ETC(U)
FEB 78 V E WILSON F33615-76-C-3021

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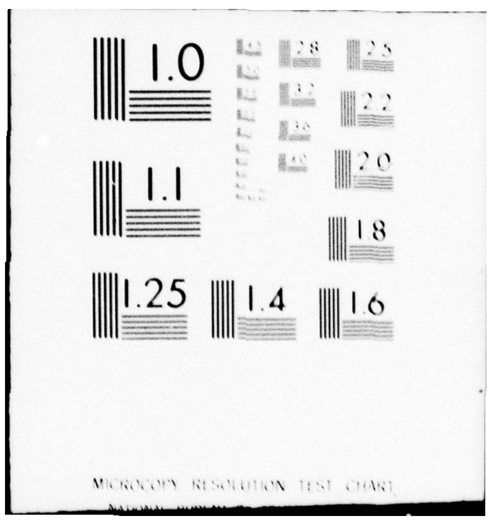

1.0
2.8
2.5
3.2
2.2
3.6
4.0
2.0
1.1
1.8
1.25
1.4
1.6
MICROCOPY RESOLUTION TEST CHART

(b) Flat Tire Conditions. (Cont.)

For the turning condition a vertical load factor of 1.0 shall be acting at the center of gravity (CG). The side load factor at the CG shall be the most critical value (up to 50 percent for one flat tire) of that resulting from the most severe condition specified for no flat tires. For this condition, refer to the following:

For W Taxi = 395,000
145.41 inches
174.00 inches
618.82 inches
677.75 inches

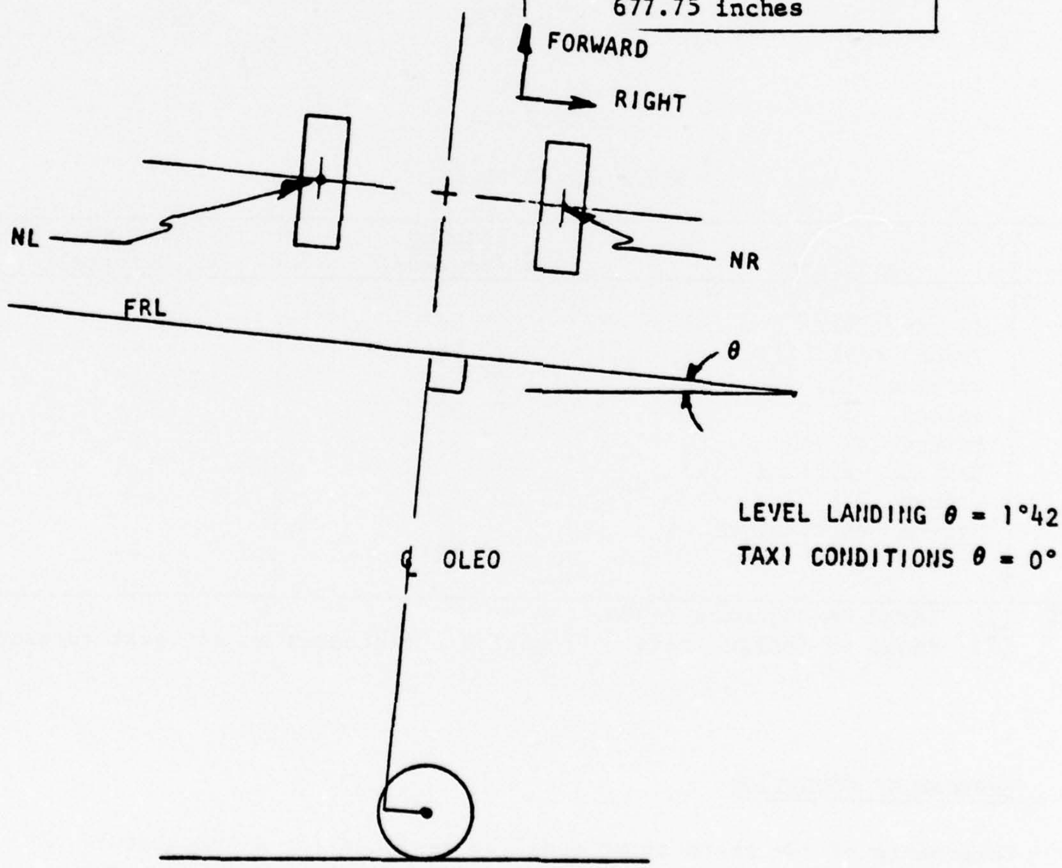


Figure C-1. Nose Gear Geometry

3. ULTIMATE LOAD DETERMINATION

Taxi and handling loads are "limit" loads and must be multiplied by 1.5 to obtain ultimate loads. Landing loads are shown as "design loads" and ultimate strength requirements do no apply; however, the deformation limitation of MIL-A-8860 shall apply. "Design Loads" will be checked versus yield strengths.

4. FUSELAGE SUPPORT STRUCTURE DEFLECTIONS

The angular rotation of the nose landing gear shock strut from its undeflected (zero-G airplane loading) position due to fuselage bending or torsion, in addition to local deflections are shown in Table C-V.

TABLE C-V

NOSE GEAR DEFLECTIONS

Item	Condition	Bending α (degrees)	Torsion θ (degrees)
a	2G taxi (1)	0° 48'	--
b	Braked roll (1)	-1° 55'	--
c	Turning (1)	0° 16'	±2° 30'
d	Spinup (2)	0° 58'	--
e	Springback (2)	-1° 12'	--
f	Maximum vertical plus drag (2)	0° 27'	--
g	Maximum vertical minus drag (2)	-1° 12'	--

NOTES (1) Based on ultimate loads.
(2) Based on design loads. Positive α indicates an aft gear rotation.

5. TEMPERATURE CONDITION

Components of the shock strut shall be designed for a temperature condition of 160 F at time of application of landing and taxi loads. This condition is subsequent to 313 hours of exposure to an ambient temperature of 265 F.

6. DROP TEST REQUIREMENTS

Drop tests shall be conducted in accordance with MIL-T-6053, except the test conditions shall be as shown in Table C-VI.

TABLE C-VI

DROP TEST CONDITIONS

Item	Airplane Weight	Attitude (degrees)	Contact Vertical Velocity (fps)	Contact Horizontal Velocity (fps)	Max Gear Load Factor
a	WL normal	Level	10	242	2.40
b	WL maximum	Level	8	279	2.24
c	WL minimum	Level	10	193	4.80
d	WL normal (flat strut)	Level	8	242	2.40

Additional Drop Test Requirements. During the drop test, loads shall not reach a peak value until at least 15 percent of the total stroke has been used. The shock strut dynamic characteristics should approximate the data shown in Table C-VII

TABLE C-VII

DYNAMIC CHARACTERISTICS

Item	Nomenclature	Characteristics
a	Static position	Inches from extended position: 14
b	Compression ratio	7.41; stroke zero to 14 inches 3.47; stroke 14 to 21 inches
c	Damping coefficient	See Figure C-2

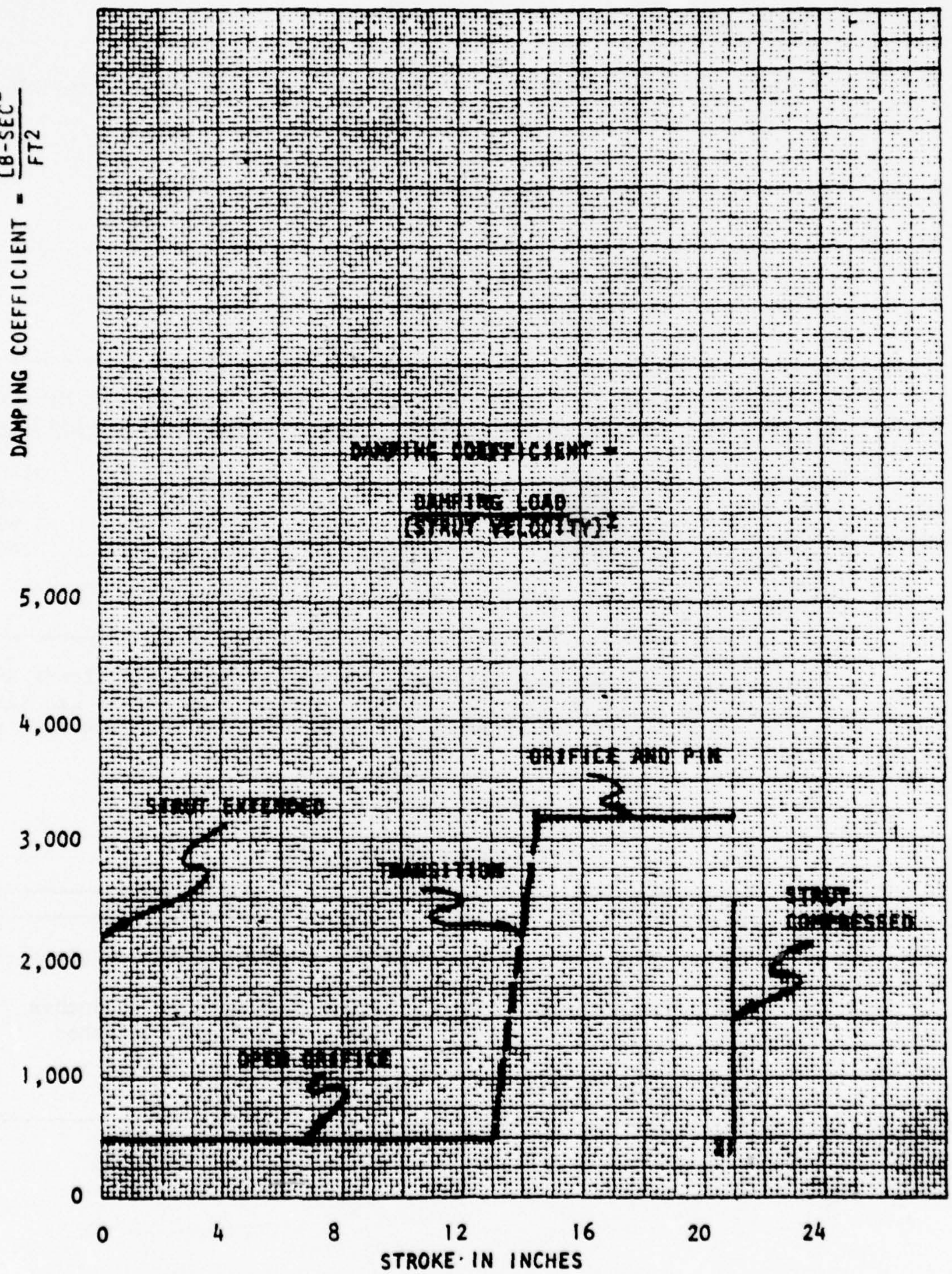


Figure C-2. Damping Requirements for Nose Gear Strut

7. ACTUATION SYSTEM LOADS

a. The nose landing gear assembly shall be structurally capable of withstanding exposure to 340-knot airloads without sustaining damage.

b. The nose landing gear assembly shall be capable of operating (retraction and extension) at airspeeds up to 280 knots.

c. Wheel, tire, and steering and damping equipment weight per nose landing gear assembly shall not exceed 439 pounds (tires and wheels 259 pounds; steering unit 180 pounds).

Actuation Load Conditions. Static and fatigue strength conditions are as follows:

Condition I: Static Strength Conditions (see Figure C-3).

a. Yield Requirements:

IA1C Piston driving, compression
IA1T Piston driving, tension
IA2C Airload plus inertia loads driving, compression

b. Ultimate Requirements:

$$IB1C = [IA1C]\ \frac{6{,}000}{5{,}400}$$

$$IB1T = [IA1T]\ \frac{6{,}000}{5{,}400}$$

$$IB2C = [IA2C]\ [1.50]$$

Condition II: Fatigue Strength Requirements (see Figure C-4).

Where: R = Retraction phase
E = Extension phase
IIR + IIE = 1 cycle
6,000 cycles = 1 life
@ Scatter factor = 4.0
Total requirement = (6,000)(4.0) = 24,000 cycles

ACTUATION LOAD CONDITIONS - STATIC

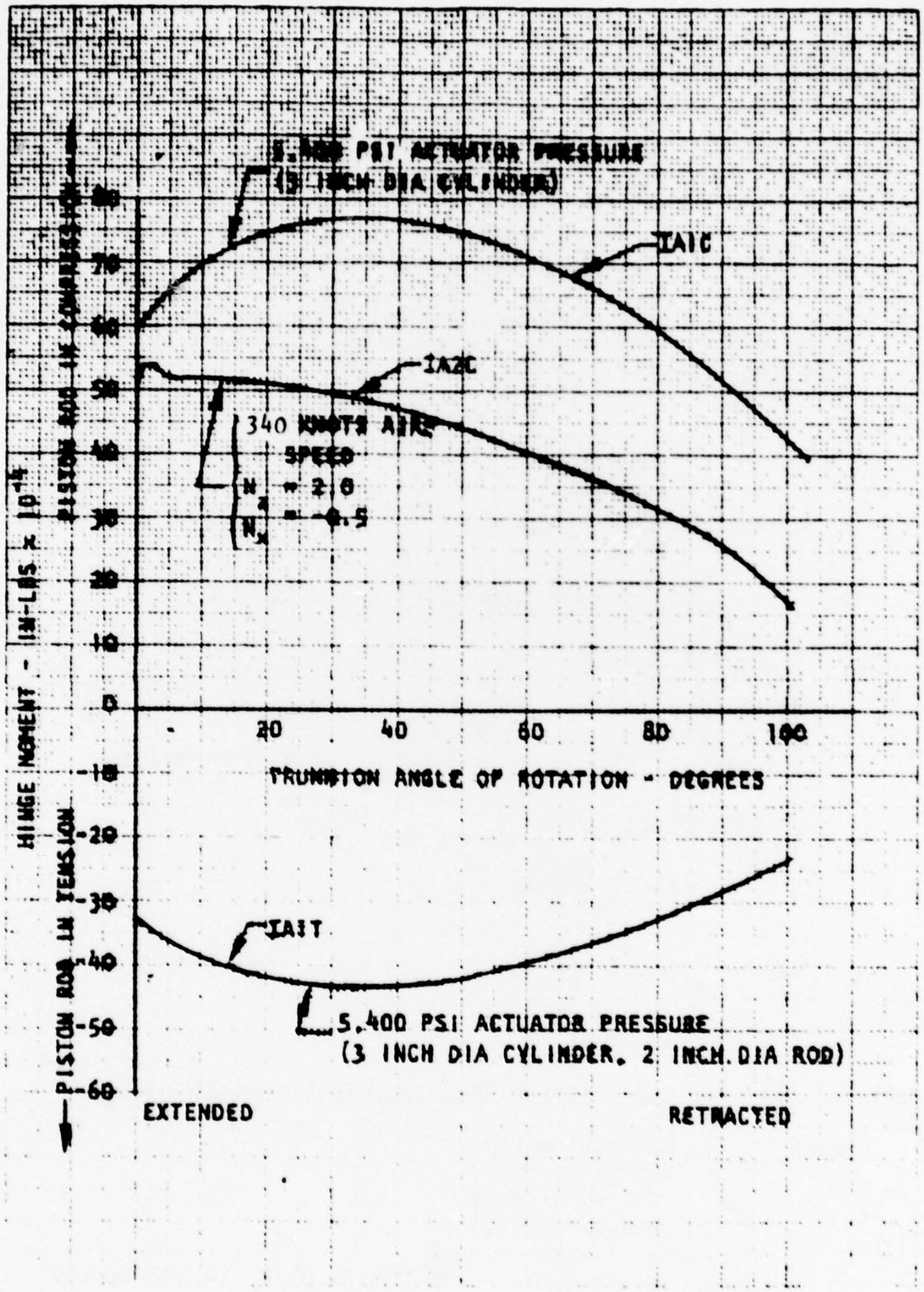


Figure C-3. Nose Gear Hinge Moment vs Retraction Angle (Static Yield Conditions)

ACTUATION LOAD CONDITIONS - FATIGUE

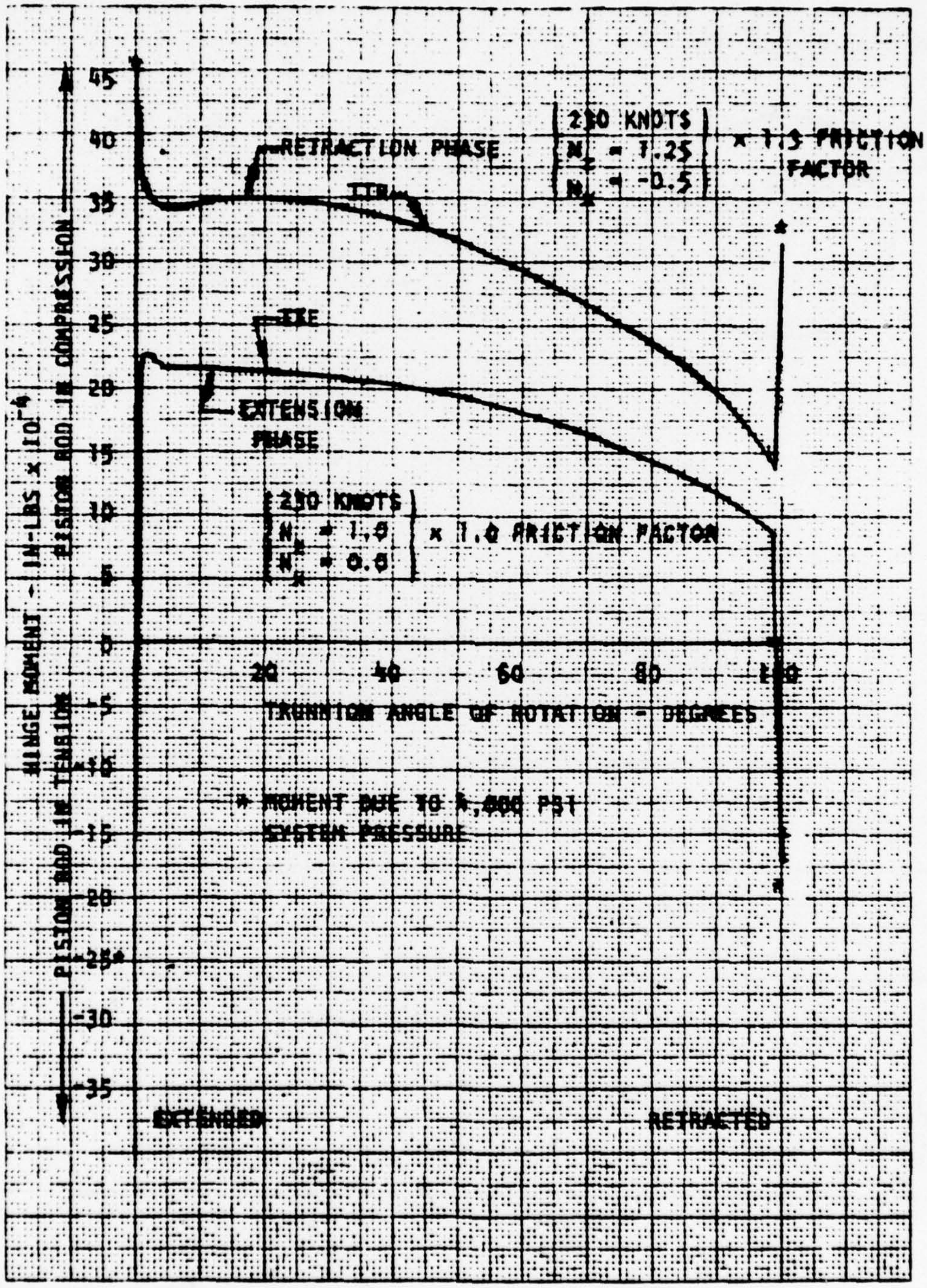
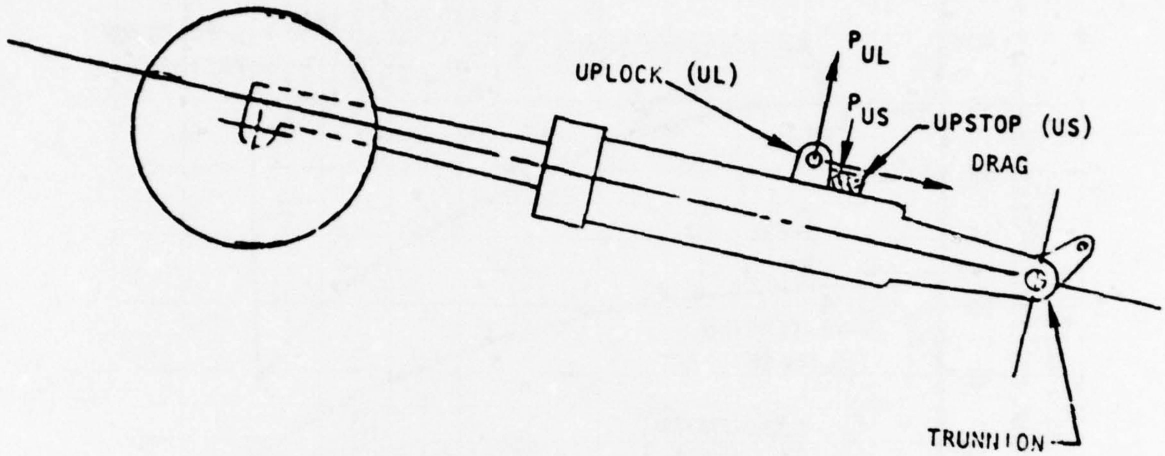


Figure C-4. Nose Gear Hinge Moment vs Retraction Angle
(Fatigue Cycles)

8. NOSE GEAR UPLOCK LOADS



	CONDITION	P_{UL} (POUNDS)	P_{US} (POUNDS)
(1)	VERTICAL GUST ($+N_z$)	7,126	---
(3)	ACTUATION SURGE PRESSURE (5,400 LB-INCHES)	---	5,969
(2)	ACTUATION ULTIMATE PRESSURE (6,000 LB-INCHES)	---	6,777

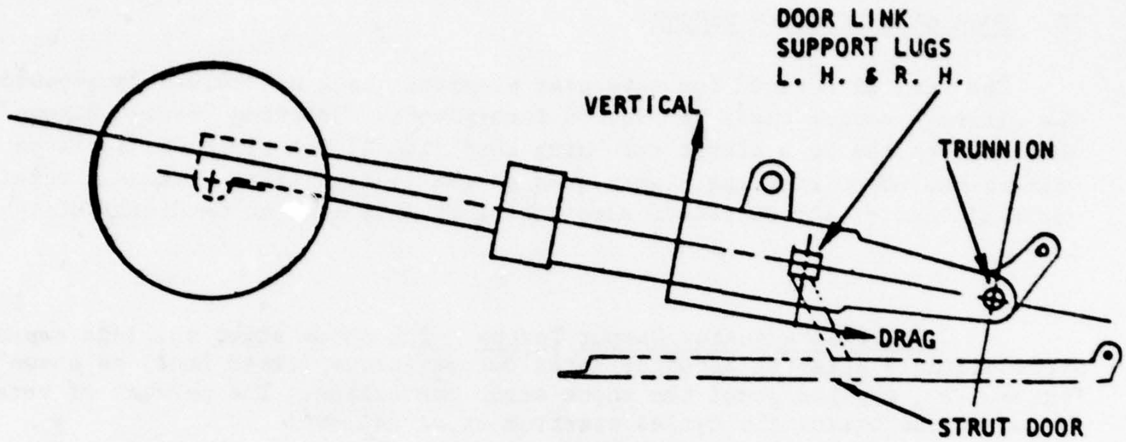
(1) VERTICAL GUST CONDITIONS ARE LIMIT LOAD CONDITIONS.
ULTIMATE = (1.50) X (LIMIT)

(2) EQUIVALENT TO ULTIMATE LOADS

(3) YIELD LOADS

Figure C-5. Nose Gear Uplock Loads

9. NOSE GEAR DOOR LINK LOADS



GEAR UP POSITION SHOWN

	CONDITION	VERTICAL LOAD (POUNDS)	DRAG LOAD (POUNDS)
DOOR	OPEN GEAR DOWN AIR SPEED 340 KT*	-2,760	-950
DOOR	OPEN GEAR DOWN AIR SPEED 280 KT	-1,865	-640
DOOR	CLOSED 2 PSI NEGATIVE PRESSURE	-1,100	1,230

*AIRSPEED OF 340 KNOTS IS A DESIGN LOAD. REFER TO 10.3.7 "a" FOR REQUIREMENT.

OTHER CONDITIONS SHOWN ARE LIMIT LOAD CONDITIONS.

LOADS SHOWN ARE FOR THE LEFT-HAND SIDE. LOADS OF THE SAME MAGNITUDE ALSO ACT ON THE RIGHT-HAND SIDE.

Figure C-6. Nose Gear Door Link Loads

10. NOSE GEAR STEERING TORQUE

The "design torque" for nose gear steering shall be 350,000 inch-pounds. The ultimate torque shall be 390,000 inch-pounds. Steering "design torque" shall be reacted by a static scrubbing condition of the tires and shall be distributed 60/40 with the higher load at the leading tire. Assume a total vertical load of 40,700 pounds also acting at this time to be distributed 60/40.

Steering Actuator Output Torque. The shock strut shall be capable of withstanding a steering actuator rated output torque (rated load) as shown on Figure C-7 , applied about the shock strut centerline. The percent of rated output torque versus the cycles spectrum is as follows:

a. Full steering angle (75 degrees right and left) at 100 percent rated output torque; 50,000 cycles.

b. Fifty percent steering angle (37-1/2 degrees right and left) at 50 percent rated output torque; 25,000 cycles.

c. Ten degrees steering angle each side of the shock strut centerline at 25 percent rated output torque; 25,000 cycles.

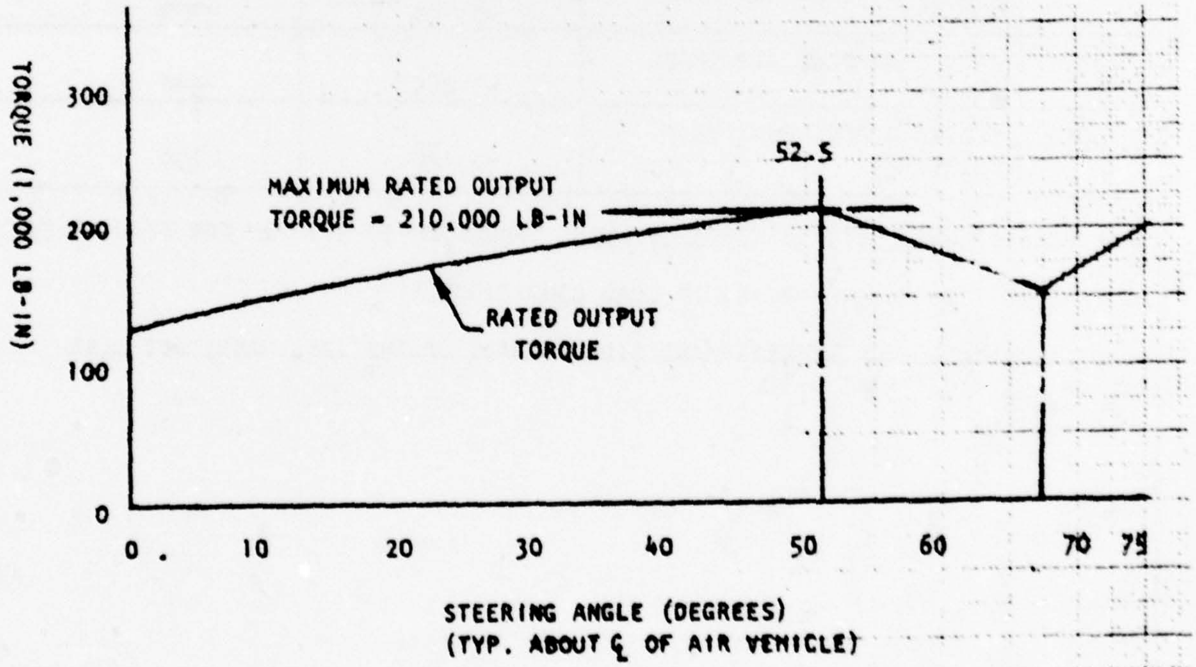


Figure C-7. Steering Actuator Rated Output Torque

11. REPEATED LOAD DESIGN REQUIREMENTS

The requirements are based on 2697 landings.

Loads Spectrum. The following landing, ground handling, and taxi spectrum (Table C-VIII) comprise the repeated load design requirements for one life of the aircraft. However, a scatter factor of 4.0 is required for both the fatigue analysis and test program.

Actuation System Requirements. The nose landing gear shock strut and the appropriate actuating mechanism shall be designed to withstand 6000 retraction/extension cycles.

TABLE C-VIII (Ref. L287C2037 Amed. 2)

NOSE LANDING GEAR TEST SPECTRUM - BLOCK LOADING

Step	Sub Step	Mission Segment	Vertical Load Kips		Drag Load Kips		Side Load Kips		Cycles Per Block
			Max	Min	Max	Min	Max	Min	
1	a	Landing	20.5	20.5	11.1	-6.4	0.	0.	
	b	(Spin Up & Spring Back)	20.5	20.5	5.5	-3.2			7
	c	Take off	0.	0.	0.	0.			
2	a	Landing	26.1	26.1	9.9	-5.4			
	b	(spin Up & Spring Back)	26.1	26.1	4.9	-2.7			64
		Take off	0.	0.	0.	0.			
3	a	Landing	26.1	26.1	9.9	-5.4			
	b	(Spin Up & Spring Back)	26.1	26.1	4.9	-2.7			64
	c	Take off	0.	0.	0.	0.			
4		Hard Braking	50.6	20.6					64
5			41.9	16.3					192
6			61.7	33.9					64
7		Medium Braking	35.7	19.9					64
8			30.1	16.3			0.		512
9		Left Turn	31.5	31.5			-12.6		128
10			18.5	18.5			-7.4		512
11			31.5	31.5			12.6		128
12		Right Turn	18.5	18.5			7.4		512
13			48.7	25.1			0.		64
14			41.7	26.1					960
15			40.7	19.3					64
16		Taxi	38.6	21.4					448
17			36.3	23.7					2688
18			21.4	11.3					640
19			20.0	12.7	0.	0.	0.	0.	2176

TABLE C-VIII - Continued
NOSE LANDING GEAR TEST SPECTRUM - BLOCK LOADING

Step	Sub Step	Mission Segment	Vertical Load Kips		Drag Load Kips		Side Load Kips		Cycles Per Block
			Max	Min	Max	Min	Max	Min	
20		Towing	33.9	33.9	29.6	-29.6	0.	0.	128
21			30.0	30.0	23.2	-23.2	0.	0.	256
22			16.3	16.3	14.6	-14.6	0.	0.	384
23			33.9	33.9	13.9	-13.9	13.9	-13.9	64
24			30.0	30.0	10.9	-10.9	10.9	-10.9	192
25			16.3	16.3	6.8	- 6.8	6.8	-6.3	320
26		Ground-Air-Ground	74.9	0.0	0.0	0.0	0.0	0.0	64

The nose landing gear block loading spectrum represents 64 composite missions. One block of loads consists of all load steps 1 through 26.
Steps 1 through 3 each contain 3 sub-steps (a through c) which are applied in order each time that particular load step is applied. Thus, steps 1 through 3 contain 9 sub steps or 405 load cycles. The block spectrum has 11,029 cycles per block or 220,580 cycles per lifetime (20 blocks per life).

Notes

1. Sign Convention
   + Vertical Load - Up Load
   + Drag Load - Aft Load
   + Side Load - Load to the right side

2. Synchronization of Loads

   For each spectrum step all loads shown as maximum loads, (i.e., vertical load, drag load, side load applied simultaneously. Similarly for each spectrum step all loads shown as minimum are applied simultaneously.

NOSE LANDING GEAR TEST SPECTRUM - (Continued)

NOTES - Continued

3. Loads application Points and Strut Setting

All nose gear loads except towing loads are applied at the ground line. The towing loads are applied at the towing attachment, 10.13 inches above the axle center line.

An average strut stroke setting of 5.0 inches (measured from fully extended position) may be used for the landing segments, and a strut stroke setting of 14.0 inches may be used for all other segments.

12. NOSE LANDING GEAR SUPPORT REACTIONS

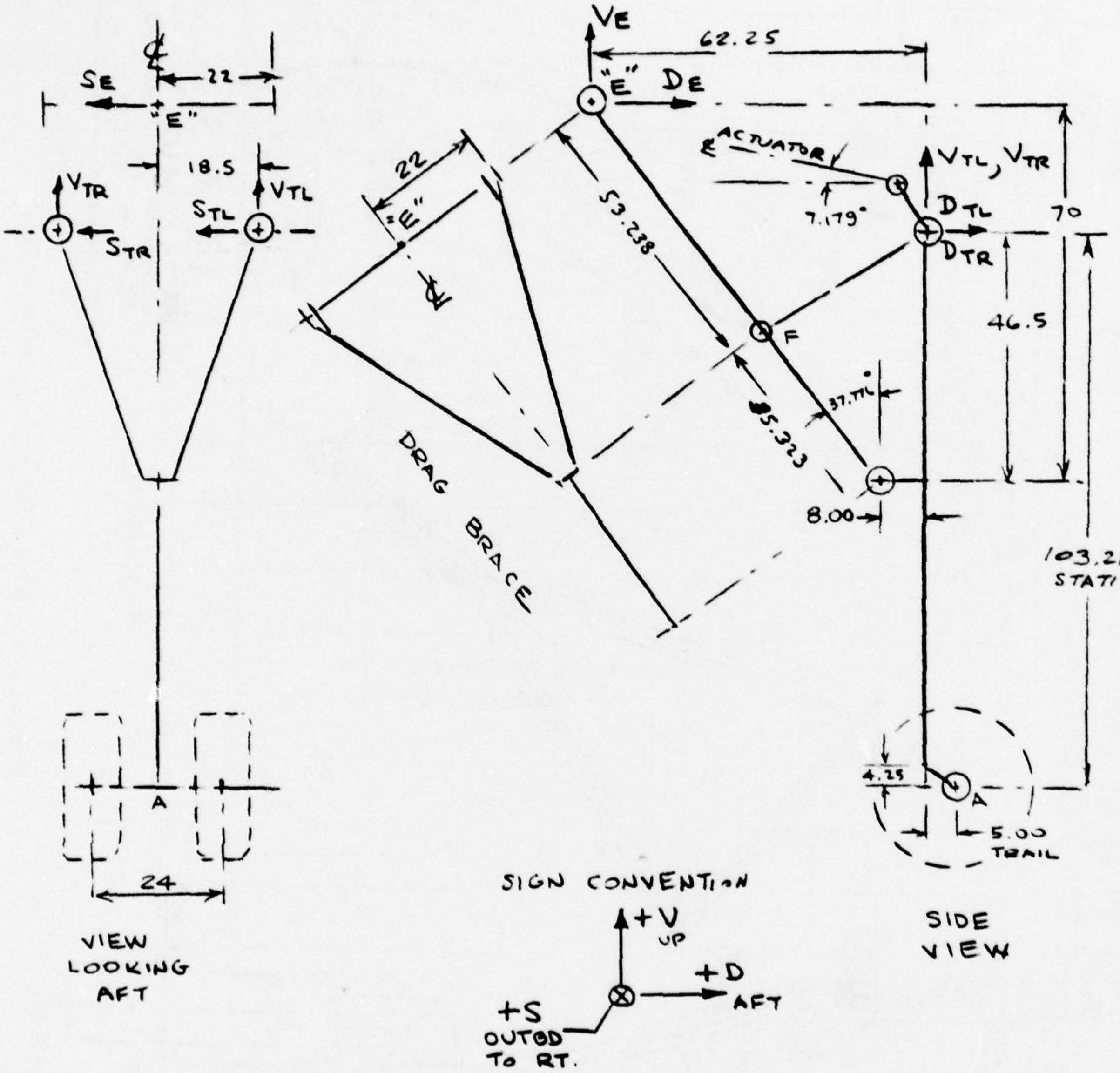


Figure C-8. Schematic - Nose Gear

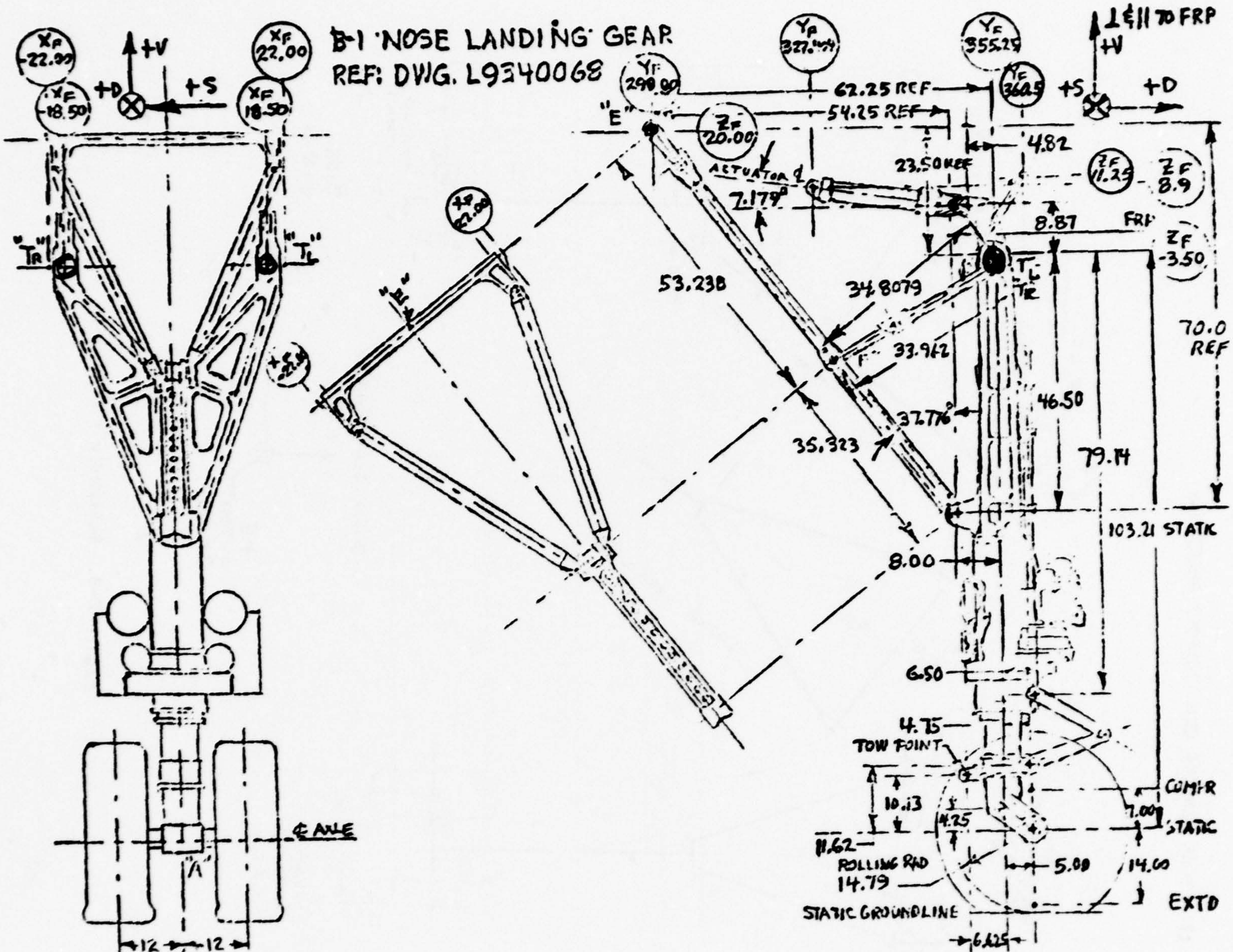


Figure C-9. Nose Gear - Support Reactions

TABLE C-IX

"DESIGN" DYNAMIC LANDING LOAD REACTIONS

(1) Check "Design" Loads Versus Yield Strengths
(2) Ultimate Check Not Required
Nose Gear Support Reactions (Ref. SDM - II-B-10.2.7.2, Sht. 2.1)

CCND.	L,R	DE	SE	VE	DTL	STL	VTL	DTR	STR	VTR
SPIN UP	5,5	-112024.	0.	144528.	47609.	51859.	-104403.	47689.	-51659.	-104403.
SPIN UP	6,4	-112027.	146.	144558.	45435.	51791.	-108006.	49794.	-51937.	-100820.
SPIN UP	4,6	-112027.	-146.	144558.	49794.	51937.	-100820.	45435.	-51791.	-108006.
SPIN UP	1,0	-67038.	434.	86504.	28343.	30286.	-73851.	41315.	-30720.	-52967.
SPIN UP	0,1	-67038.	-434.	86504.	41315.	30720.	-52967.	28343.	-30266.	-73851.
SPR BACK	5,5	79738.	0.	-102894.	-2671.	-1522.	501.	-2671.	1522.	501.
SPR BACK	6,4	79738.	-152.	-102894.	-769.	-1446.	-6276.	-4573.	1599.	7277.
SPR BACK	4,6	79738.	152.	-102894.	-4573.	-1599.	7277.	-769.	1446.	-6276.
SPR BACK	1,0	43752.	-448.	-56458.	12151.	64.	-21624.	878.	385.	15248.
SPR BACK	0,1	43752.	448.	-56458.	878.	-385.	15248.	12151.	-64.	-21624.
MAX V +D	5,5	-72310.	6.	93307.	38992.	48892.	-97752.	38992.	-48892.	-97752.
MAX V +D	6,4	-72310.	68.	93307.	37805.	48858.	-104217.	40179.	-48926.	-91287.
MAX V +D	4,6	-72310.	-68.	93307.	40179.	48926.	-91287.	37805.	-48858.	-104217.
MAX V +D	1,0	-42587.	204.	54953.	25833.	28385.	-76586.	32841.	-28538.	-41010.
MAX V +D	0,1	-42587.	-204.	54953.	32841.	28538.	-41010.	25833.	-28385.	-76586.

DESIGN - REF. DEFORMATION REQTS - MIL-A-8860(ASG)
/UP, AFT, AND RIGHT POSITIVE - RIGHT HAND RULE FOR MOMENTS

ABOVE REACTIONS INCLUDE REACTIONS DUE TO ACTUATORS (Ref. Sht. 5.1)

TABLE C-X

"LIMIT" TAXI AND HANDLING REACTIONS

(Ref. SDM II B-10.2.7.2 Sht. 3.1 and Sht. 4.1)

ACTUATOR REACTIONS INCL'D (Ref. Sht. 5.1)

COND.	L,R	DE	SE	VE	DTL	STL	VTL	DTR	STR	VTR
LFT TURN	5,5	-7705.	-146.	9941.	20619.	17239.	-62291.	18287.	-3030.	14582.
LFT TURN	4,6	-7705.	-142.	9941.	20630.	17237.	-60333.	18277.	-3032.	12624.
LFT TURN	1,0	-7716.	-112.	9956.	20134.	14620.	-57738.	18784.	-5718.	9901.
LFT TURN	0,1	-7716.	-70.	9957.	20242.	14599.	-38151.	18676.	-5739.	-9685.
RGT TURN	5,5	-7705.	146.	9941.	18287.	3030.	14582.	20619.	-17239.	-62291.
RGT TURN	6,4	-7705.	142.	9941.	18277.	3032.	12624.	20630.	-17237.	-60333.
RGT TURN	1,0	-7716.	70.	9957.	18676.	5739.	-9685.	20242.	-14599.	-38151.
RGT TURN	0,1	-7716.	112.	9956.	18784.	5718.	9901.	20134.	-14620.	-57738.
UNSM B+S	5,5	-10605.	187.	13684.	19465.	9505.	10065.	22417.	-27518.	-89010.
UNSM B-S	5,5	-10605.	-187.	13684.	22417.	27518.	-89010.	19465.	-9505.	10065.
3 PT B R	5,5	-12537.	0.	16177.	22184.	25609.	-52698.	22184.	-25609.	-52698.
3 PT B R	6,4	-12537.	-13.	16177.	22180.	25616.	-59053.	22188.	-25602.	-47342.
3 PT B R	4,6	-12537.	13.	16177.	22188.	25602.	-47342.	22180.	-25616.	[illegible]
3 PT B R	1,0	-9998.	-43.	12901.	20706.	17830.	-56163.	20785.	-17837.	-20324.
3 PT B R	0,1	-9998.	43.	12901.	20785.	17837.	-20324.	20706.	-17860.	-56163.
TAXI	5,5	-14354.	0.	13522.	22909.	28423.	-57973.	22909.	-23423.	-57973.
TAXI	6,4	-14354.	-13.	18522.	22885.	28430.	-63929.	22933.	-28417.	-52017.
TAXI	4,6	-14354.	13.	18522.	22933.	28417.	-52017.	22685.	-28430.	-53920.
TAXI	1,0	-10837.	-42.	13983.	20982.	19264.	-60120.	21161.	-19221.	-21552.
TAXI	0,1	-10837.	42.	13983.	21161.	19221.	-21552.	20982.	-19264.	-60120.

ACTUATOR REACTIONS NOT INCLUDED

COND.	L,R	DE	SE	VE	DTL	STL	VTL	DTR	STR	VTR
5A TOW	5,5	97225.	0.	-125449.	-18718.	-23555.	46189.	-18718.	23555.	46187.
5A TOW	6,4	97225.	-6.	-125449.	-18706.	-23552.	44230.	-18730.	23558.	48147.
5A TOW	4,6	97225.	6.	-125449.	-18730.	-23558.	48147.	-18706.	23552.	44230.
5A TOW	1,0	97225.	-29.	-125449.	-18656.	-23540.	36395.	-18780.	23570.	55982.
5A TOW	0,1	97225.	29.	-125449.	-18780.	-23570.	55982.	-18656.	23540.	36395.
6A TOW	5,5	-102275.	0.	131965.	21275.	43123.	-82576.	21275.	-43123.	-82576.
6A TOW	6,4	-102275.	-3.	131965.	21242.	43124.	-84529.	21309.	-43121.	-80623.
6A TOW	4,6	-102275.	3.	131965.	21309.	43121.	-80623.	21242.	-43124.	-84529.
6A TOW	1,0	-102275.	-13.	131965.	21106.	43129.	-92341.	21444.	-43116.	-72811.
6A TOW	0,1	-102275.	13.	131965.	21444.	43116.	-72811.	21106.	-43129.	-92341.

(1) Check ULTIMATE Case as 1.5 x "LIMIT" values.

TABLE C-X

"LIMIT" TAXI AND HANDLING REACTIONS (Cont.)

COND.	L,R	DE	SE	VE	DTL	STL	VTL	DTR	STR	VTR
7A TOW	5,5	103727.	0.	-133839.	-21969.	-25644.	50384.	-21969.	25644.	50384.
7A TOW	6,4	103727.	-6.	-133839.	-21957.	-25641.	48425.	-21982.	25647.	52343.
7A TOW	4,6	103727.	6.	-133839.	-21982.	-25647.	52343.	-21957.	25641.	48425.
7A TOW	1,0	103727.	-29.	-133839.	-21908.	-25630.	40590.	-22031.	25659.	60177.
7A TOW	0,1	103727.	29.	-133839.	-22031.	-25659.	60177.	-21908.	25630.	40590.
8A TOW	5,5	-96081.	0.	123973.	18179.	41132.	-78580.	18174.	-41132.	-78586.
8A TOW	6,4	-96081.	-3.	123973.	18145.	41134.	-80533.	18212.	-41131.	-76627.
8A TOW	4,6	-96081.	3.	123973.	18212.	41131.	-76627.	18145.	-41134.	-80533.
8A TOW	1,0	-96081.	-13.	123973.	18010.	41134.	-88345.	18348.	-41126.	-68815.
8A TOW	0,1	-96081.	13.	123973.	18348.	41126.	-68815.	18010.	-41139.	-88345.
9A TOW	5,5	33109.	54.	-42720.	-5916.	-12873.	48438.	-6028.	-8819.	-39176.
9A TOW	6,4	24195.	49.	-44122.	-6441.	-13220.	47770.	-6592.	-8463.	-37306.
9A TOW	4,6	32123.	59.	-41318.	-5395.	-12527.	49111.	-5465.	-9171.	-41256.
9A TOW	1,0	38540.	29.	-49729.	-8532.	-14606.	45075.	-8846.	-7062.	-28804.
9A TOW	0,1	27677.	79.	-35711.	-3304.	-11140.	51801.	-3211.	-10577.	-49548.
10A TOW	5,5	-37454.	57.	48327.	8385.	10708.	8448.	7973.	-32405.	-90273.
10A TOW	6,4	-38522.	56.	49705.	8883.	11057.	6365.	6542.	-32748.	-89561.
10A TOW	4,6	-36516.	58.	46949.	7887.	10365.	10531.	7463.	-32062.	-90978.
10A TOW	1,0	-42763.	52.	55216.	10876.	12426.	-1967.	10621.	-34118.	-86747.
10A TOW	0,1	-32114.	45.	41436.	5807.	8999.	9433.	5216.	-30683.	-84368.
11A TOW	5,5	37637.	62.	-48563.	-8082.	-14332.	57176.	-8393.	-7368.	-42076.
11A TOW	6,4	38723.	57.	-49965.	-8605.	-14678.	56503.	-8957.	-7017.	-39996.
11A TOW	4,6	36551.	67.	-47161.	-7559.	-13985.	57846.	-7829.	-7720.	-44145.
11A TOW	1,0	43169.	37.	-55572.	-10696.	-16065.	53813.	-11211.	-5611.	-31698.
11A TOW	0,1	32205.	56.	-41554.	-5468.	-12599.	60539.	-5575.	-9126.	-52442.
12A TOW	5,5	-33103.	40.	42584.	6197.	9287.	5601.	5710.	-30966.	-81083.
12A TOW	6,4	-31935.	41.	41206.	5698.	8943.	7654.	5141.	-30624.	-82388.
12A TOW	4,6	-34071.	39.	43962.	6695.	9630.	3518.	6280.	-31309.	-80978.
12A TOW	1,0	-27664.	45.	35694.	3705.	7569.	16010.	2863.	-29253.	-85209.
12A TOW	0,1	-38342.	35.	49473.	8688.	11005.	-4814.	8558.	-32679.	-76158.
JACK	+D	-35028.	0.	45197.	9559.	26141.	-49454.	9559.	-26141.	-49454.
JACK	+D,+S	-35028.	47.	45197.	9701.	18162.	-11454.	9417.	-34119.	-87453.
JACK	+S	-5390.	47.	6955.	2837.	8306.	7740.	2553.	-24259.	-68411.
JACK	-D,+S	24375.	46.	-31451.	-4090.	-1602.	27024.	-4375.	-14345.	-49288.
JACK	-D	24375.	0.	-31451.	-4232.	6377.	-11130.	-4232.	-6377.	-11130.

NOSE LANDING GEAR SUPPORT REACTIONS

DUE TO RETRACTION ACTUATORS: (Sheet 5.1)

During normal ground operation (landing and taxi, not towing or jacking) the retraction actuators are pressurized to extend the gear. (400 psi on the net area).

Net Area = 3.927 in^2

Pact = 3.927 x 4000 = 15708 lbs. each (LIMIT)

The resulting support reactions are:

Drag Brace, Pt. E	DE =	-4533
	SE =	0
	VE =	5849
Left Trunnion	DTL =	17851
	STL =	-50
	VTL =	-4887
Right Trunnion	DTR =	17851
	STR =	50
	VTR =	-4887

(Ref. SDM IIB-10.2.7.2, Sht. 5.1)

APPENDIX D

ENVIRONMENTAL DATA

APPENDIX D

ENVIRONMENTAL DATA

A. THERMODYNAMIC ENVIRONMENT DATA

The B-1 System Definition Manual lists the following external environment data.

The temperature, pressure, and contaminant conditions to which the air vehicle and subsystem equipment will be exposed are defined in this section. Time of exposure and equipment operational requirements for both ground and flight conditions are defined, including alert, start, takeoff, and in-flight normal and emergency ECS operation.

1. System Surrounding Environment. The weapon system shall be capable of meeting specified worldwide conditions of weather and climate. Values for the extremes of worldwide climate shall be as specified in MIL-STD-210.

2. Storage and Transit. The weapon system (air vehicle and equipment) shall be capable of being started up after warmup to minus 65 F and performing as required after being subjected to the following storage and transit temperature and pressure conditions:

a.	Temperature	Minue 80 to plus 160F
b.	Pressure	1.68 to 15.4 psia
c.	Humidity	Minus 65 to plus 85 F dewpoint
d.	Rain	32-inch rainfall in 24-hour period at 70F as shown by Table C-1.
e.	Blowing Sand	10 to 1,000 micron diameter with predominant diameters between 150 and 300 microns; wind, 40 mph

e. (continued)	at 5-foot height; temperature, 100 F; concentration of sand 10 pounds per foot cross section
f. Blowing Dust	6 x 10^{-9} grams/cc; 1 to 10 micron diameter; 40 mph at height of 5 feet; temperature, 70 F

TABLE D-I RAINFALL PROPERTIES

Applicable to packaging for storage and transit and to air vehicle

		CONDITION			
ITEM	CRITERIA	1	2	3	4
a.	Amount (inches)	12	2	11*	7
b.	Duration (hours-minutes)	11:55	0:05	11:00	1:00
c.	Rate (inch/hour)	1	24	1	7
d.	Drop Size (mm), mean	2.25	4.0	2.25	3.2
e.	Standard Deviation (mm)	0.77	1.68	0.77	1.1

* Wind speed of 40 mph (35 knots) during this portion of cycle

3. Temperature and Altitude (Pressure). Installed equipment shall withstand exposure to the surrounding steady-state and transient temperature and pressure conditions specified below:

TABLE D-II

AIR VEHICLE EQUIPMENT SURROUNDING TEMPERATURE AND PRESSURE CONDITIONS

ENVIRONMENTAL PARAMETERS TEMPERATURE °F	UNCOOLED EQUIPMENT UNPRESSURIZED COMPARTMENTS WHEEL WELL BAYS
GROUND	
Nonoperating	-80 to 203
Operating	-65 to 203
INFLIGHT	
NORMAL	
Nonoperating	-65 to 265
Operating	-65 to 265
EMERGENCY	
Operating and Nonoperating	
5 Minute Duration	----
Extended Duration	----
TRANSIENT °F/sec	3.0
PRESSURE paia	
GROUND	
Operating and Nonoperating	10.1 to 15.4
Compartment Pressure Test	----

AIR VEHICLE EQUIPMENT SURROUNDING TEMPERATURE AND PRESSURE CONDITIONS (continued)

ENVIRONMENTAL PARAMETERS TEMPERATURE °F	UNCOOLED EQUIPMENT UNPRESSURIZED COMPARTMENTS WHEEL WELL BAYS
INFLIGHT	
Normal	
Operating and Nonoperating	.65 to 15.4
EMERGENCY	
Operating and Nonoperating	
5 Minute Duration	----
Extended Duration	----
TRANSIENT psi/sec	0.5

4. Humidity. The humidity of surrounding air will range from zero to 182 grains of water per pound of dry air, including the condition of moisture condensation in the form of liquid or frost.

5. Rain. The ground rain environment for the air vehicle and external equipment will be the operational worldwide ground precipitation extremes. Inflight rain shall be a design consideration for erosion, leakage, and vision through transparent areas.

6. Icing. Air vehicle components and equipment exposed to the external environment will experience icing conditions within the aircraft operating envelope bounded by airspeeds up to mach 0.85 at sea level, mach 1.1 at 8,000 feet, and mach 1.2 at 20,000 feet.

7. Salt Fog and Spray. The air vehicle and installed equipment will be exposed to salt-sea atmosphere having particle sizes as small as 1.0 micron in diameter.

8. Hail. The air vehicle and externally mounted equipment may be exposed to hailstones having a diameter up to 3/4 inch.

9. Sand and Dust. Dust particles will vary from 0.1 to 10 microns in diameter, and sand particles will vary from 10 to 1,000 microns in diameter, with predominant diameters less than 300 microns, at a velocity of 1,750 plus or minus 250 feet per minute. The sand and dust concentration will be up to 0.5 gram per cubic foot of air.

10. Fungus. The air vehicle and equipment will be exposed to fungus growth as encountered in tropical climates.

B. VIBRATION, ACOUSTIC NOISE, SHOCK AND ACCELERATION ENVIRONMENT DATA.

The B-1 Prime Item Development Specification lists the following data:

1. Vibration. The vibration levels to which the equipment shall be exposed is specified in Tables C-3 and C-4 and are composite curves of the predicted maximum vibration level encountered during air vehicle operation throughout the flight envelope.

2. Mass Attenuation. The air vehicle vibration levels in Tables C-3 and C-4 shall be reduced for equipment weight in excess of 80 pounds.

3. Acoustics. The maximum aircraft equipment noise level encountered during operation within the flight envelope shall be as shown by the internal and external operating noise levels in Table C-7. The equipment internal levels shall be based on the external levels and structural noise transmission loss.

4. Shock. Equipment design shall be based on the requirement to withstand and operate without malfunction during or after exposure, for a duration of 11 plus or minus 1 milliseconds, to:
   a. Sawtooth shock pulses of 20G peak magnitude for rigidly mounted equipment weighing less than 300 pounds, or
   b. Half-sine wave shock pulses of 15G peak magnitude for shock mounted equipment, or equipment weighing 300 pounds or more.

TABLE D-III

SINUSOIDAL VIBRATION LEVELS - EQUIPMENT OPERATING

Frequency Range Cycles per Second (cps)	Double Amplitude (da) Acceleration (G)
Nose gear wheel well Nose gear (shock strut)	
5 to 10	0.2 inch da displacement
10 to 100	1G peak

TABLE D-IV

RANDOM VIBRATION LEVEL - EQUIPMENT OPERATING

Frequency Range Cycles per Second (cps)	Acceleration Power Spectral Density
Nose gear wheel well Nose gear (shock strut)	
20 to 300	3 db per octave increase
300 to 1,000	0.2. G^2 per cps
1,000 to 2,000	6 db per octave decrease

TABLE D-V

SINUSOIDAL VIBRATION LEVELS - EQUIPMENT NONOPERATING

(ACCELERATED TEST)

Frequency Range Cycles per Second (cps)	Double Amplitude (da)/ Acceleration (G)
Nose gear wheel well Nose gear (shock strut)	
5 to 10	0.27 inch da displacement
10 to 100	1.35G peak

TABLE D-VI

RANDOM VIBRATION LEVELS - EQUIPMENT NONOPERATING

(ACCELERATED TEST)

Frequency Range Cycles per Second (cps)	Acceleration Power Spectral Density
Nose gear wheel well Nose gear (shock strut)	
20 to 300	3 db per octave increase
300 to 1,000	$0.037G^2$ per cps
1,000 to 2,000	6 db per octave decrease

TABLE D-VII

MAXIMUM OVERALL ACOUSTIC NOISE LEVELS (DB)
(REFERENCED TO 0.0002 DYNE PER SQUARE CENTIMETER)

ZONE	EXTERNAL EQUIPMENT		INTERNAL EQUIPMENT	
	OPERATING	NONOPERATING	OPERATING	NONOPERATING
Nose Gear	147	151	132	136

TABLE D-VIII

SINUSOIDAL - RANDOM EQUIVALENT - EQUIPMENT OPERATING

Frequency Range Cycles per Second (cps)	Double Amplitude (da)/ Acceleration (G)
Nose gear wheel well	
Nose gear (shock strut)	
5 to 10	0.2 inch da displacement
10 to 140	1G peak
140 to 200	0.001 inch da displacement
200 to 2,000	2G peak

TABLE D-IX

SINUSOIDAL-RANDOM EQUIVALENT - EQUIPMENT NONOPERATING

Frequency Range Cycles per Second (cps)	Double Amplitude (da)/ Acceleration (G)
Nose gear wheel well	
Nose gear (shock strut)	
5 to 10	0.27 inch da displacement
10 to 140	1.35G peak
140 to 200	0.0014 inch da displacement
200 to 2,000	2.7G peak

TABLE D-X

SPECIAL ENVIRONMENTS

EXTENDED LANDING GEAR - UNSPRUNG MASS

Frequency Range Cycles per Second (cps)	Double Amplitude (da)/ Acceleration (G)
Nose gear (axle assembly)	
Sinusoidal Operating	
5 to 24	0.5 inch da displacement
24 to 2,000	15G peak
Sinusoidal Nonoperating	
5 to 28	0.5 inch da displacement
28 to 2,000	20G peak

TABLE D-X (Continued)

SPECIAL ENVIRONMENTS

EXTENDED LANDING GEAR - UNSPRUNG MASS (continued)

Frequency Range Cycles per Second (cps)	Double Amplitude (da)/ Acceleration (G)
Wheels	
Sinusoidal Operating	
5 to 34	0.5 inch da displacement
34 to 2,000	30G peak
Sinusoidal Nonoperating	
5 to 39	0.5 inch da displacement
39 to 2,000	40G peak

APPENDIX E

MAINTENANCE ANALYSIS DATA

TABLE E-I

ON-AIRCRAFT CORRECTIVE MAINTENANCE ANALYSIS

SYSTEM NOMENCLATURE - Main Gear Assembly - Metallic Baseline PREPARED BY - R. Sandoval D/312

WUC - 13XXX PART NO - D619-3A DATE - 9-7-77

LRU WUC NO.	LRU PART NO.	LRU NOMENCLATURE	QTY PER A/C	UNIT COST $	MDR PER 1000 FH	MAINTENANCE TASK DESCRIPTION		TASK TIME MIN.	MAINTENANCE SUPPORT RESOURCES OSE (ID)	PERSONNEL AFSC	PERSONNEL QTY	OTHER (SPECIFY)
13CDA9C	TBD	Tire (Remove & Replace Defective or Worn Tire)	2	505	10	Fault Verification & Isolation	☒	5	None	43151	1	
						Inspection						
						Prep for R&R						
						Secure	☐					
						Access	☒					
						Drain	☐					
						Jack A/C		30	1 Jack	43171	1	
						Remove & Replace	☒	15	1 Jack	43171	1	
						Assy & Dis-Assy	☐					
						Prep for Checkout						
						Service	☒					
						Safety	☐					
						Hookup	☐					
						Inflate Tire		5	GN_2 Bottle	43151	2	
						Checkout	☐					
						Closeout	☒	5	None	43151	1	

TABLE E-I

ON-AIRCRAFT CORRECTIVE MAINTENANCE ANALYSIS

SYSTEM NOMENCLATURE - Main Gear Assembly - Metallic Baseline   PREPARED BY - R. Sandoval D/312
WUC - 13XXX   PART NO - D619-3A   DATE - 9-7-77

LRU WUC NO.	LRU PART NO.	LRU NOMENCLATURE	QTY PER A/C	UNIT COST $	MDR PER 1000 FH	MAINTENANCE TASK DESCRIPTION		TASK TIME MIN.	MAINTENANCE SUPPORT RESOURCES OSE (ID)	PERSONNEL AFSC	PERSONNEL QTY	OTHER (SPECIFY)
13EAC	TBD	Brake Stack Assy.	2	3434	78	Fault Verification & Isolation	☒	5	None	43151	1	
						Check Wear						
						Prep for R&R						
						Secure	☐					
						Access	☒					
						Drain	☐					
						Jack A/C		30	Jacks	43151	1	
						Remove & Replace	☒	15	Tools	43151	1	
						Assy & Dis-Assy	☐					
						Prep for Checkout						
						Service	☐					
						Safety	☐					
						Hookup	☒	15		43151	1	Hyd Cart Elect Cart
						Checkout	☒	10		43151	2	" "
						Activate Brakes						
						Closeout	☐	5	None	43151	1	
					6.5	Adjust Brakes Every 50 Landings		40	Jacks		2	

TABLE E-I

ON-AIRCRAFT CORRECTIVE MAINTENANCE ANALYSIS

SYSTEM NOMENCLATURE - Main Gear Assembly - Metallic Baseline　　PREPARED BY - R. Sandoval D/312
WUC - 13XXX　　PART NO - D619-3A　　DATE - 9-7-77

LRU WUC NO.	LRU PART NO.	LRU NOMENCLATURE	QTY PER A/C	UNIT COST $	MDR PER 1000 FH	MAINTENANCE TASK DESCRIPTION		TASK TIME MIN.	MAINTENANCE SUPPORT RESOURCES: OSE (ID)	PERSONNEL AFSC	PERSONNEL QTY	OTHER (SPECIFY)
13EBE	TBD	Brake Actuator Assembly	2	2290	.78	Fault Verification & Isolation	☐					
						Prep for R&R						
						Secure	☐					
						Access	☒		Con-			
						Drain	☒	10	tainer	43151	1	
						Jack A/C		30	Jacks		1	
						Remove & Replace	☒	15	Tools	43151	1	
						Assy & Dis-Assy	☒	15	Tools	43151	1	
						Prep for Checkout						
						Service	☒	10	Hyd Ser	43151	1	
						Safety	☐		Unit			Hyd Cart
						Hookup	☒	15			1	Elect Cart
						Checkout	☒	10		43151	2	" "
						Operate Brakes						
						Closeout	☐	5	None	43151	1	

TABLE E-I

ON-AIRCRAFT CORRECTIVE MAINTENANCE ANALYSIS

SYSTEM NOMENCLATURE - Main Gear Assembly - Metallic Baseline   PREPARED BY - R. Sandoval D/312
WUC - 13XXX   PART NO - D619-3A   DATE - 9-7-77

LRU WUC NO.	LRU PART NO.	LRU NOMENCLATURE	QTY PER A/C	UNIT COST $	MDR PER 1000 FH	MAINTENANCE TASK DESCRIPTION		TASK TIME MIN.	MAINTENANCE SUPPORT RESOURCES: OSE (ID)	PERSONNEL: AFSC	PERSONNEL: QTY	OTHER (SPECIFY)
13CBL	TBD	Strut Hyd. Actuator	2	1517	.15	Fault Verification & Isolation						
						Inspect	☒	5	None	43151	1	
						Prep for R&R						
						Secure	☐					
						Access	☐					
						Drain	☒	10	Fluid Container	43151	1	
						Remove & Replace	☒	15	Tools	43151	1	
						Assy & Dis-Assy	☐					
						Prep for Checkout						
						Service	☒	10	Hyd. Cart	43151	1	
						Safety	☐					
						Hookup	☒					Hyd Cart Elect Cart
						Checkout Swing Gear	☒	30		43151	3	" "
						Closeout	☐	5	None	43151	1	

TABLE E-I

ON-AIRCRAFT CORRECTIVE MAINTENANCE ANALYSIS

SYSTEM NOMENCLATURE - Main Gear Assembly - Metallic Baseline
WUC - 13XXX PART NO - D619-3A

PREPARED BY - R. Sandoval D/312
DATE - 9-7-77

LRU WUC NO.	LRU PART NO.	LRU NOMENCLATURE	QTY PER A/C	UNIT COST $	MDR PER 1000 HI	MAINTENANCE TASK DESCRIPTION		TASK TIME MIN.	MAINTENANCE SUPPORT RESOURCES OSE (ID)	PERSONNEL AFSC	PERSONNEL QTY	OTHER (SPECIFY)
13BAA9A	TBD	MLG Cylinder	2	28,584	.135	Fault Verification & Isolation Verify Leaks	☒	10	None	43151	1	
						Prep for R&R						
						Secure	☐					
						Access	☒					
						Drain	☒					
						Jack A/C Depressurize GN_2 Drain Hyd.		30	Jacks Hyd Con-tainer	43151	2	
						Remove & Replace	☐					
						Assy & Dis-Assy Replace Seals	☒	30		43151	2	
						Prep for Checkout						
						Service	☒	15		43151	2	
						Safety	☐					
						Hookup	☒	15	Hyd Cart GN_2 2000 psi	43151	2	
						Checkout	☒	15	"	43151	2	
						Closeout	☐	5	None	43151	1	

TABLE E-I

ON-AIRCRAFT CORRECTIVE MAINTENANCE ANALYSIS

SYSTEM NOMENCLATURE - Main Gear Assembly - Metallic Baseline   PREPARED BY - R. Sandoval D/312
WUC - 13XXX   PART NO - D619-3A   DATE - 9-7-77

LRU WUC NO.	LRU PART NO.	LRU NOMENCLATURE	QTY PER A/C	UNIT COST $	MDR PER 1000 FH	MAINTENANCE TASK DESCRIPTION		TASK TIME MIN.	MAINTENANCE SUPPORT RESOURCES OSE (ID)	PERSONNEL AFSC	PERSONNEL QTY	OTHER (SPECIFY)
13CDA9*	TBD	Wheel Assy. (R&R	2	2888	.125	Fault Verification & Isolation	[X]	5	None	43151	1	
						Inspection						
						Prep for R&R						
						Secure	[ ]					
						Access	[X]					
						Drain	[ ]					
						Jack A/C		30	Jacks	43151	3	
						Remove & Replace	[X]		Jacks	43151	2	
						Assy & Dis-Assy	[ ]		Tools			
						Prep for Checkout						
						Service	[ ]					
						Safety	[ ]					
						Hookup	[X]	5	None	43151	1	
						Checkout	[ ]	10	Pwr.	43151	3	Hyd. Cart Elect. Pwr. Cart
						Closeout	[ ]	5	None	43151	1	

TABLE E-I

ON-AIRCRAFT CORRECTIVE MAINTENANCE ANALYSIS

SYSTEM NOMENCLATURE - Main Gear Assembly - Metallic Baseline   PREPARED BY - R. Sandoval D/312
WUC - 13XXX   PART NO - D619-3A   DATE - 9-7-77

LRU WUC NO.	LRU PART NO.	LRU NOMENCLATURE	QTY PER A/C	UNIT COST $	MDR PER 1000 FH	MAINTENANCE TASK DESCRIPTION		TASK TIME MIN.	MAINTENANCE SUPPORT RESOURCES			
									OSE (ID)	PERSONNEL		OTHER (SPECIFY)
										AFSC	QTY	
13BAC1	TBD	Down Lock Assembly	2	2009	.083	Fault Verification & Isolation	☒					
						Jack A/C, Inspect Rigging		30	Jacks	43151	3	Hyd. Cart Elect. Cart
						Prep for R&R						
						Secure	☐					
						Access	☐					
						Drain	☐					
						Remove & Replace	☒	20	Jacks	43151	1	
						Assy & Dis-Assy	☐					
						Prep for Checkout						
						Service	☐					
						Safety	☐					
						Hookup	☒	15		43151	3	Hyd. Cart Elect. Cart
						Checkout	☒					
						Swing Gear		15	Jacks	43151	3	Hyd. Cart Elect. Cart
						Closeout	☐	10	None	43151	1	

TABLE E-I

ON-AIRCRAFT CORRECTIVE MAINTENANCE ANALYSIS

SYSTEM NOMENCLATURE - Main Gear Assembly - Metallic Baseline
WUC - 13XXX   PART NO - D619-3A

PREPARED BY - R. Sandoval D/312
DATE - 9-7-77

LRU WUC NO.	LRU PART NO.	LRU NOMENCLATURE	QTY PER A/C	UNIT COST $	MDR PER 1000 HI	MAINTENANCE TASK DESCRIPTION		TASK TIME MIN.	MAINTENANCE SUPPORT RESOURCES: OSE (ID)	PERSONNEL: AFSC	PERSONNEL: QTY	OTHER (SPECIFY)
13BAC2	TBD	Up-Lock Assy.	2	2009	083	Fault Verification & Isolation	☒					
						Jack A/C, Inspect Rigging		30	Jacks	43151	3	Hyd Cart Elect Cart
						Prep for R&R						
						Secure	☐					
						Access	☐					
						Drain	☐					
						Remove & Replace	☒	20	Jacks	43151	1	
						Assy & Dis-Assy	☐					
						Prep for Checkout						
						Service	☐					
						Safety	☐					
						Hookup	☒	15		43151	3	Hyd Cart Elect Cart
						Checkout	☒					
						Swing Gear		15	Jacks	43151	3	Hyd Cart Elect Cart
						Closeout	☐	10	None	43151	1	

TABLE E-I

ON-AIRCRAFT CORRECTIVE MAINTENANCE ANALYSIS

SYSTEM NOMENCLATURE - Main Gear Assembly - Metallic Baseline
WUC - 13XXX   PART NO - D619-3A

PREPARED BY - R. Sandoval D/312
DATE - 9-7-77

LRU WUC NO.	LRU PART NO.	LRU NOMENCLATURE	QTY PER A/C	UNIT COST $	MDR PER 1000 HI	MAINTENANCE TASK DESCRIPTION		TASK TIME MIN.	MAINTENANCE SUPPORT RESOURCES			
									OSE (ID)	PERSONNEL		OTHER (SPECIFY)
										AFSC	QTY	
13BAQ1	TBD	Torque Link, Upper	2	820	.011	Fault Verification & Isolation	☒					
						Inspect Wear & Alignment		30	Alignment Tools	43151	1	
						Prep for R&R						
						Secure	☐					
						Access	☐					
						Drain	☐					
						Remove & Replace	☒	30	Tools	43151	2	
						Assy & Dis-Assy	☐					
						Prep for Checkout						
						Service (Grease)	☒	15	Grease Gun	43151	1	
						Safety	☐					
						Hookup	☐					
						Checkout	☒	15	Tools	43151	2	
						Closeout	☐					

TABLE E-I

ON-AIRCRAFT CORRECTIVE MAINTENANCE ANALYSIS

SYSTEM NOMENCLATURE - Main Gear Assembly - Metallic Baseline
WUC - 13XXX PART NO - D619-3A

PREPARED BY - R. Sandoval D/312
DATE - 9-7-77

LRU WUC NO.	LRU PART NO.	LRU NOMENCLATURE	QTY PER A/C	UNIT COST $	MDR PER 1000 FH	MAINTENANCE TASK DESCRIPTION		TASK TIME MIN.	MAINTENANCE SUPPORT RESOURCES: OSE (ID)	PERSONNEL: AFSC	PERSONNEL: QTY	OTHER (SPECIFY)
13BAQ2	TBD	Torque Link, Lower		820	.011	Fault Verification & Isolation	☒					
						Inspect Wear & Alignment		30	Align-ment Tools	43151	1	
						Prep for R&R						
						Secure	☐					
						Access	☐					
						Drain	☐					
						Remove & Replace	☒	30	Tools	43151	2	
						Assy & Dis-Assy	☐					
						Prep for Checkout						
						Service (Grease)	☒	15	Grease Gun	43151	1	
						Safety	☐					
						Hookup	☐					
						Checkout	☒	15	Tools	43151	2	
						Check Alignment						
						Closeout	☐					

TABLE E-I

ON-AIRCRAFT CORRECTIVE MAINTENANCE ANALYSIS

SYSTEM NOMENCLATURE - Main Gear Assembly - Metallic Baseline PREPARED BY - R. Sandoval D/312
WUC - 13XXX PART NO - D619-3A DATE - 9-7-77

LRU WUC NO.	LRU PART NO.	LRU NOMENCLATURE	QTY PER A/C	UNIT COST $	MDR PER 1000 FH	MAINTENANCE TASK DESCRIPTION		TASK TIME MIN.	MAINTENANCE SUPPORT RESOURCES			
									OSE (ID)	PERSONNEL		OTHER (SPECIFY)
										AFSC	QTY	
13BAA9B	TBD	MLG Piston	2	26,412	.007	Fault Verification &						
						Isolation	[X]					
						Inspection		10	None	43151	1	
						Prep for R&R						
						Secure	[ ]					
						Access	[X]					
						Drain	[X]					
						Jack A/C		30	Jacks	43151	3	
						Drain Hyd		15	Hyd Cart	"	2	
						Dump GN_2 Press.		10	N/A	43151	2	
						Remove & Replace	[X]	60	Tools	43151	3	
						Assy & Dis-Assy	[ ]					
						Prep for Checkout						
						Service GN_2 Hyd	[X]	30	GN_2 Hyd Cart	43151	3	
						Safety	[ ]					
						Hookup	[ ]					
						Checkout	[ ]					
						Closeout	[ ]					

TABLE E-I

ON-AIRCRAFT CORRECTIVE MAINTENANCE ANALYSIS

<u>SYSTEM NOMENCLATURE</u> - Main Gear Assembly - Metallic Baseline   <u>PREPARED BY</u> - R. Sandoval D/312
<u>WUC</u> - 13XXX   <u>PART NO</u> - D619-3A   <u>DATE</u> - 9-7-77

LRU WUC NO.	LRU PART NO.	LRU NOMENCLATURE	QTY PER A/C	UNIT COST $	MDR PER 1000 FH	MAINTENANCE TASK DESCRIPTION		TASK TIME MIN.	MAINTENANCE SUPPORT RESOURCES: OSE (ID)	PERSONNEL: AFSC	PERSONNEL: QTY	OTHER (SPECIFY)
13GCB	TBD	Anti-Skid Detector	2	807	.0068	Fault Verification & Isolation	☒					
						Check Detector		15	Anti-Skid Test Set	42350	2	
						Prep for R&R						
						Secure	☐					
						Access	☐					
						Drain	☐					
						Remove & Replace	☒	15	Tools	42350	1	
						Assy & Dis-Assy	☐					
						Prep for Checkout						
						Service	☐					
						Safety	☐					
						Hookup	☒	15	Anti-Skid Test Set	42350	1	
						Checkout	☒					
						Rotate Sensor		10	"	42350	2	Elect Pwr. Cart
						Closeout	☒	5		42350	1	

TABLE E-I

ON-AIRCRAFT CORRECTIVE MAINTENANCE ANALYSIS

SYSTEM NOMENCLATURE - Main Gear Assembly - Metallic Baseline
WUC - 13XXX PART NO - D619-3A

PREPARED BY - R. Sandoval D/312
DATE - 9-7-77

LRU WUC NO.	LRU PART NO.	LRU NOMENCLATURE	QTY PER A/C	UNIT COST $	MDR PER 1000 FH	MAINTENANCE TASK DESCRIPTION		TASK TIME MIN.	MAINTENANCE SUPPORT RESOURCES: OSE (ID)	PERSONNEL: AFSC	PERSONNEL: QTY	OTHER (SPECIFY)
13BAA9C	TBD	Axle	2	8650	.005	Fault Verification & Isolation	☒					
						Inspection		10	None	43151	1	
						Prep for R&R						
						Secure	☐					
						Access	☒	Remove Wheel & Brake Assy 13CDAD*, 13EAC, 13EBE				See LRU Shts for Details
						Drain	☒					
						Remove & Replace	☒	30	Tools	43151	3	
						Assy & Dis-Assy	☐					
						Prep for Checkout						
						Service	☒	Covered in Maint. of in the way Removal Items (GN_2 & Hyd.)				
						Safety	☐					
						Hookup	☐					
						Checkout Inspection	☒	10		43151	1	Hyd. Cart Elect. Cart
						Closeout	☒	10		43151	2	

TABLE E-II

OFF-AIRCRAFT CORRECTIVE MAINTENANCE ANALYSIS

SYSTEM NOMENCLATURE - Main Gear Assembly - Metallic Baseline PREPARED BY - R. Sandoval D/312
WUC - 13XXX PART NO - D619-3A DATE - 9-7-77

LRU WUC NO.	LRU PART NO.	LRU NOMENCLATURE	QTY PER A/C	UNIT COST $	MDR PER 1000 FH	MAINTENANCE TASK DESCRIPTION		TASK TIME MIN.	MAINTENANCE SUPPORT RESOURCES			
									OSE (ID)	PERSONNEL AFSC	PERSONNEL QTY	OTHER (SPECIFY)
13CDA9C	TBD	Tire	2	505	10	R&R Tire from Wheel Assy.						Retread or New Tire
						Fault Verification & Isolation	☐					
						Prep for R&R						
						Secure	☐					
						Access	☐					
						Drain	☐					
						Remove & Replace	☒	20	Tools	42354	1	Holding Fixture
						Assy & Dis-Assy	☐					
						Prep for Checkout						
						Service	☒					
						Safety	☐					
						Hookup	☐					
						Inflate		10	GN_2 Source	42354	1	GN_2 & Tire Inflation Cage
						Checkout	☐					
						Closeout	☐					

TABLE E-II

OFF-AIRCRAFT CORRECTIVE MAINTENANCE ANALYSIS

SYSTEM NOMENCLATURE - Main Gear Assembly - Metallic Baseline
WUC - 13XXX PART NO - D619-3A

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DATE - 9-7-77

LRU WUC NO.	LRU PART NO.	LRU NOMENCLATURE	QTY PER A/C	UNIT COST $	MDR PER 1000 HI	MAINTENANCE TASK DESCRIPTION		TASK TIME MIN.	MAINTENANCE SUPPORT RESOURCES: OSE (ID)	PERSONNEL: AFSC	PERSONNEL: QTY	OTHER (SPECIFY)
13EAC	TBD	Brake Stack Assy.		3434	.78	R&R Disks						
						Fault Verification & Isolation	☐					
						Prep for R&R						
						Secure	☐					
						Access	☐					
						Drain	☐					
						Remove & Replace	☐					
						Assy & Dis-Assy	☒	30	Bench Tools	53150	1	Replace W/New Discs Discard Old Discs
						Prep for Checkout						
						Service	☐					
						Safety	☐					
						Hookup	☐					
						Checkout	☒	10	None	53150	1	
						Closeout	☐					

TABLE E-II

OFF-AIRCRAFT CORRECTIVE MAINTENANCE ANALYSIS

SYSTEM NOMENCLATURE - Main Gear Assembly - Metallic Baseline PREPARED BY - R. Sandoval D/312
WUC - 13XXX PART NO - D619-3A DATE - 9-7-77

LRU WUC NO.	LRU PART NO.	LRU NOMENCLATURE	QTY PER A/C	UNIT COST $	MDR PER 1000 HI	MAINTENANCE TASK DESCRIPTION		TASK TIME MIN.	MAINTENANCE SUPPORT RESOURCES OSE (ID)	PERSONNEL AFSC	PERSONNEL QTY	OTHER (SPECIFY)
13EBE	TBD	Brake Actuator Assy.	2	2290	.78	Repair Cylinder(s)						
						Fault Verification & Isolation	☐					
						Prep for R&R						
						Secure	☐					
						Access	☐					
						Drain	☐					
						Remove & Replace	☐					
						Assy & Dis-Assy	☒	60	Bench Tools	42354	1	
						Prep for Checkout						
						Service	☐					
						Safety	☐					
						Hookup	☒	10	Actuator Test Set	42354	1	Hyd Pwr.
						Checkout	☒	15	Actuator Test Set	42354	1	
						Closeout	☐					

TABLE E-II

OFF-AIRCRAFT CORRECTIVE MAINTENANCE ANALYSIS

SYSTEM NOMENCLATURE - Main Gear Assembly - Metallic Baseline
WUC - 13XXX PART NO - D619-3A

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DATE - 9-7-77

LRU WUC NO.	LRU PART NO.	LRU NOMENCLATURE	QTY PER A/C	UNIT COST $	MDR PER 1000 FH	MAINTENANCE TASK DESCRIPTION		TASK TIME MIN.	MAINTENANCE SUPPORT RESOURCES: OSE (ID)	PERSONNEL: AFSC	PERSONNEL: QTY	OTHER (SPECIFY)
13CBL	TBL	Strut Hyd. Actuator	2	1517	.15							
						Fault Verification & Isolation	[X]	15	Actuator			
						Verify Failure			Stand	42354	1	
						Prep for R&R						
						Secure	[ ]					
						Access	[ ]					
						Drain	[ ]					
						Remove & Replace	[ ]					
						Assy & Dis-Assy	[X]					
						Clean, Replace Seals		60	Depot	53150	1	Depot
						Refinish			Equipt			Actuator
						Prep for Checkout						Sta.
						Service	[ ]					
						Safety	[ ]					
						Hookup	[ ]					
						Checkout	[X]	15	Actuator			
									Stand	42354	1	
						Closeout	[ ]					

TABLE E-II

OFF-AIRCRAFT CORRECTIVE MAINTENANCE ANALYSIS

SYSTEM NOMENCLATURE - Main Gear Assembly - Metallic Baseline   PREPARED BY - R. Sandoval D/312
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LRU WUC NO.	LRU PART NO.	LRU NOMENCLATURE	QTY PER A/C	UNIT COST $	MDR PER 1000 FH	MAINTENANCE TASK DESCRIPTION		TASK TIME MIN.	MAINTENANCE SUPPORT RESOURCES OSE (ID)	PERSONNEL AFSC	PERSONNEL QTY	OTHER (SPECIFY)
13BAA9A	TBD	MLG Cylinder	2	28,584	.135							
						Fault Verification & Isolation	☐					
						Prep for R&R						
						Secure	☐					
						Access	☐					
						Drain	☐					
						Remove & Replace	☐					
						Assy & Dis-Assy	☒					
						Clean, Replace Upper Seals, Refinish		60	Depot Equip.	53150	1	Depot Actuator Sta.
						Prep for Checkout						
						Service	☐					
						Safety	☐					
						Hookup	☐					
						Checkout	☒	15	Actuator Test Stand	42354	1	Depot Test Sta.
						Closeout	☐					

TABLE E-II

OFF-AIRCRAFT CORRECTIVE MAINTENANCE ANALYSIS

SYSTEM NOMENCLATURE - Main Gear Assembly - Metallic Baseline
WUC - 13XXX PART NO - D619-3A

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LRU WUC NO.	LRU PART NO.	LRU NOMENCLATURE	QTY PER A/C	UNIT COST $	MDR PER 1000 HI	MAINTENANCE TASK DESCRIPTION		TASK TIME MIN.	MAINTENANCE SUPPORT RESOURCES: OSE (ID)	PERSONNEL: AFSC	PERSONNEL: QTY	OTHER (SPECIFY)
13CDA9*	TBD	Wheel Assy (Replace Bearings) (2)	2	2888	.125	R&R Bearings						
						Fault Verification & Isolation	☐					
						Prep for R&R						
						Secure	☐					
						Access	☐					
						Drain	☐					
						Remove & Replace	☒	15	None	53150	1	
						Assy & Dis-Assy	☐					
						Prep for Checkout						
						Service	☒	10	None	53150	1	
						Safety	☐					
						Hookup	☐					
						Grease Bearings						
						Checkout Inspection	☒	10	None	53150	1	
						Closeout	☐					

TABLE E-II

OFF-AIRCRAFT CORRECTIVE MAINTENANCE ANALYSIS

SYSTEM NOMENCLATURE - Main Gear Assembly - Metallic Baseline
WUC - 13XXX **PART NO** - D619-3A

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DATE - 9-7-77

LRU WUC NO.	LRU PART NO.	LRU NOMENCLATURE	QTY PER A/C	UNIT COST $	MDR PER 1000 HI	MAINTENANCE TASK DESCRIPTION		TASK TIME MIN.	MAINTENANCE SUPPORT RESOURCES: OSE (ID)	PERSONNEL: AFSC	PERSONNEL: QTY	OTHER (SPECIFY)
13BAC1	TBD	Down Lock Assy.	2	2009	.083	Repair Hyd. Actuator						
						Fault Verification & Isolation	☒	15	Hyd Test Stand	42354	1	
						Prep for R&R						
						Secure	☐					
						Access	☐					
						Drain	☐					
						Remove & Replace	☐					
						Assy & Dis-Assy	☒	30	Bench Tools	42354	1	
						Prep for Checkout						
						Service	☐					
						Safety	☐					
						Hookup	☐					
						Checkout	☒	15	Hyd Test Stand	42354	1	
						Closeout	☐					

TABLE E-II

OFF-AIRCRAFT CORRECTIVE MAINTENANCE ANALYSIS

SYSTEM NOMENCLATURE - Main Gear Assembly - Metallic Baseline   PREPARED BY - R. Sandoval D/312
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13BAC2	TBD	Uplock Assy	2	2009	.083	Repair Hyd. Actuator						
						Fault Verification & Isolation	[X]	15	Hyd Test Stand	42354	1	
						Prep for R&R						
						Secure	[ ]					
						Access	[ ]					
						Drain	[ ]					
						Remove & Replace	[ ]					
						Assy & Dis-Assy	[X]	30	Bench Tools	42354	1	
						Prep for Checkout						
						Service	[X]	15	Hyd Test Stand	42354	1	
						Safety	[ ]					
						Hookup	[ ]					
						Checkout	[ ]					
						Closeout	[ ]					

TABLE E-II

OFF-AIRCRAFT CORRECTIVE MAINTENANCE ANALYSIS

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									OSE (ID)	PERSONNEL		OTHER (SPECIFY)
										AFSC	QTY	
13BAQ1	TBD	Torque Link, Upper	2	820	.011	Replace Bearings (2)						
						Fault Verification & Isolation Inspect	☒	15	None	42354	1	
						Prep for R&R						
						Secure	☐					
						Access	☐					
						Drain	☐					
						Remove & Replace	☒	20	Bearing Tool	53150	1	
						Assy & Dis-Assy	☐					
						Prep for Checkout						
						Service	☐					
						Safety	☐					
						Hookup	☐					
						Checkout	☒	15	None	53150	1	
						Closeout	☐					

TABLE E-II

OFF-AIRCRAFT CORRECTIVE MAINTENANCE ANALYSIS

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									OSE (ID)	PERSONNEL		OTHER (SPECIFY)
										AFSC	QTY	
13BAQ2	TBD	Torque Link Lower	2	820	.011	Replace Bearings (2)						
						Fault Verification & Isolation Inspection	☒	15	None	42354	1	
						Prep for R&R						
						Secure	☐					
						Access	☐					
						Drain	☐					
						Remove & Replace	☒	20	Bearing Tool	53150	1	
						Assy & Dis-Assy	☐					
						Prep for Checkout						
						Service	☐					
						Safety	☐					
						Hookup	☐					
						Checkout	☒	15	None	53150	1	
						Closeout	☐					

TABLE E-II

OFF-AIRCRAFT CORRECTIVE MAINTENANCE ANALYSIS

SYSTEM NOMENCLATURE - Main Gear Assembly - Metallic Baseline
WUC - 13XXX   PART NO - D619-3A

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LRU WUC NO.	LRU PART NO.	LRU NOMENCLATURE	QTY PER A/C	UNIT COST $	MDR PER 1000 FH	MAINTENANCE TASK DESCRIPTION		TASK TIME MIN.	MAINTENANCE SUPPORT RESOURCES			
									OSE (ID)	PERSONNEL		OTHER (SPECIFY)
										AFSC	QTY	
13BAA9B	TBD	MLG Piston	2	26,412	.007	Clean & Resurface Piston						
						Fault Verification & Isolation Inspection	☒	10	None	53150	1	Depot Gages
						Prep for R&R						
						Secure	☐					
						Access	☐					
						Drain	☐					
						Remove & Replace	☐					
						Assy & Dis-Assy Clean & Resurface	☒	30	None	53150	1	Depot Equipment
						Prep for Checkout						
						Service	☐					
						Safety	☐					
						Hookup	☐					
						Checkout Inspection	☒	10	None	53150		Depot Gages
						Closeout	☐					

TABLE E-II

OFF-AIRCRAFT CORRECTIVE MAINTENANCE ANALYSIS

SYSTEM NOMENCLATURE - Main Gear Assembly - Metallic Baseline
WUC - 13XXX   PART NO - D619-3A

PREPARED BY - R. Sandoval D/312
DATE - 9-7-77

LRU WUC NO.	LRU PART NO.	LRU NOMENCLATURE	QTY PER A/C	UNIT COST $	MDR PER 1000 HI	MAINTENANCE TASK DESCRIPTION	TASK TIME MIN.	MAINTENANCE SUPPORT RESOURCES OSE (ID)	PERSONNEL AFSC	PERSONNEL QTY	OTHER (SPECIFY)
136CB	TBD	Anti-Skid Detector	2	807	.0068						
						Fault Verification & Isolation ☐		NOTE:	THIS ITEM IS A DISCARD ITEM UPON REMOVAL FROM AIRCRAFT		
						Prep for R&R Secure ☐ Access ☐ Drain ☐			NO OFF-AIRCRAFT MAINTENANCE IS REQUIRED.		
						Remove & Replace ☐ Assy & Dis-Assy ☐					
						Prep for Checkout Service ☐ Safety ☐ Hookup ☐					
						Checkout ☐					
						Closeout ☐					

TABLE E-II

OFF-AIRCRAFT CORRECTIVE MAINTENANCE ANALYSIS

SYSTEM NOMENCLATURE - Main Gear Assembly - Metallic Baseline   PREPARED BY - R. Sandoval D/312
WUC - 13XXX   PART NO - D619-3A   DATE - 9-7-77

LRU WUC NO.	LRU PART NO.	LRU NOMENCLATURE	QTY PER A/C	UNIT COST $	MDR PER 1000 HI	MAINTENANCE TASK DESCRIPTION		TASK TIME MIN.	MAINTENANCE SUPPORT RESOURCES: OSE (ID)	PERSONNEL: AFSC	PERSONNEL: QTY	OTHER (SPECIFY)
13BAA9C	TBD	Axle	2	8650	.005	Clean and Resurface						
						Fault Verification & Isolation	☒	10	None	53150	1	Depot Gages
						Prep for R&R						
						Secure	☐					
						Access	☐					
						Drain	☐					
						Remove & Replace	☐					
						Assy & Dis-Assy	☒	30	None	53150	1	Depot Equipment
						Clean & Resurface						
						Prep for Checkout						
						Service	☐					
						Safety	☐					
						Hookup	☐					
						Checkout	☒	10	None	53150		Depot Gages
						Inspection						
						Closeout	☐					

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